Financial Integration and Growth in a Risky World

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December 19, 2013*

Abstract

We revisit the debate on the benefits of financial integration by providing a unified framework able to account for gains from capital accumulation and risk sharing. We consider a two-country neoclassical growth model with aggregate uncertainty. We allow for country asymmetries in terms of volatility, capital scarcity and size. In our general equilibrium model, financial integration has an effect on the steady-state itself. Because we use global numerical methods we are able to do meaningful welfare comparisons along the transition paths. We find differences in the effect of financial integration on growth, consumption and welfare over time and across countries. This opens the door to a much richer set of empirical implications than previously considered in the literature.

JEL Classification: **F36, F41, F43, F65.**

Key Words: Financial integration, Capital flows, Risky steady-state, Global Solutions.

*We thank Pierre-Olivier Gourinchas, Hande Kucuk-Tuger, Anna Pavlova, Robert Zymek, seminar participants at LBS Macro-Finance Workshop, Gerzensee Asset Pricing Summer Symposium, Barcelona GSE Summer Workshop, Bank of Chile, Capri/CSEF, SciencesPo Macro-Finance Workshop for helpful comments. Taha Choukhmane provided excellent research assistance. Nicolas Coeurdacier thanks the Agence Nationale pour la Recherche (Project INTPORT) and the SciencesPo-Banque de France partnership for financial support. Helene Rey thanks the European Research Council (Starting grant 210584) for financial support. Contact details: `nicolas.coeurdacier@sciences-po.fr`, `hrey@london.edu`, `pablo.winant@gmail.com`.

1 Introduction

What should we think about the welfare effects of financial integration? This is one of the perennial questions in international macroeconomics and finance. The usual answer, given by academics and taken up by policy makers, is that financial integration allows for a more efficient allocation of capital and improves risk sharing across countries. To the extent that the policy making world has been actively promoting financial integration, implicit in this answer is that *quantitatively* these gains are large enough to offset any costs associated with integration. So how large are actually the efficiency and risk sharing gains of financial integration? As the literature stands, we cannot answer this question in one go.

In the context of neoclassical growth models, capital flows from capital-abundant to capital-scarce countries and raises welfare as the marginal product of capital is higher in the latter than in the former. Free capital movements thus permit a more efficient global allocation of savings towards their most productive use. But quantitatively, as the calibrations of Gourinchas and Jeanne (2006) show in a deterministic model, those neoclassical gains to international financial integration have remained elusive. Even when a country starts off in autarky with a low level of capital, speeding up its transition towards its steady-state by opening the financial account brings small welfare gains. The reason is that the distortion induced by a lack of capital mobility is transitory: the country would have reached its steady-state level of capital regardless of financial openness, albeit at a slower speed. In this framework, only very capital-scarce countries may experience significant gains to financial integration.

In the context of the international risk-sharing literature, which usually does not feature endogenous production, openness to financial flows allows idiosyncratic country shocks to be diversified away. The debate still rages regarding the magnitude of the gains from risk-sharing (see Cole and Obstfeld (1991), van Wincoop (1994, 1999), Lewis (1999, 2000)). In most studies though, gains are of second order as financial integration allows a reduction of consumption volatility but does not affect output.[1] Empirically, welfare gains are potentially large if asset

[1]There is however a theoretical literature that studies the effect of asset trade on efficient specialization and risk taking (Obstfeld (1994), Acemoglu, and Zilibotti (1997), Martin and Rey (2006). On the empirical side, see Kalemli-Ozcan, Sørensen, and Yosha (2003). We abstract from this channel.

price data are to be trusted, but remarkably small if clues are taken from consumption data only (Lucas (1987)). Recent work aims at reconciling the two by relying either on long-run consumption risks (Colacito and Croce (2010) and Lewis and Liu (2012)) or rare disasters risks (Martin (2010)). The framework used in the one of endowment economies, shutting down neoclassical efficiency gains. In this context, financial integration may bring sizable gains but their magnitude is very sensitive to the cross-country correlation of long-run (or disaster) risks. Large welfare gains driven by realistic asset prices are also hard to reconcile with the observed degree of portfolio home-bias (see Lewis (1999) and Coeurdacier and Rey (2013) for a recent survey).

But assessing efficiency and risk sharing gains separately, using two different types of models, prevents reaching a solid conclusion. Are those two gains substitute or complement? They are surely intertwined as, through precautionary savings, the steady state level of the capital stock depends on the level of risk agents seek to insure (see Aiyagari (1995) in the context of a closed economy). Thus, when capital is allowed to flow across borders, gains from risk-sharing modify the steady-state level of the capital stock and impacts the process of capital reallocation across countries. In presence of aggregate risk, a country at its autarkic steady-state could well be capital scarce or abundant when opening up to capital markets. Financial integration can therefore have a permanent effect on output in a stochastic environment.

In this paper we model jointly gains from international risk sharing and capital efficiency in a unified framework. We present a two country stochastic growth model with heterogeneous countries and incomplete financial markets where countries are allowed to trade a risk-free bond internationally. Countries produce a single tradable good using capital and labor and face stochastic (transitory) productivity shocks. Countries are allowed to be asymmetric in three dimensions: the amount of aggregate risk they are facing, their level of capital at time of integration and their size. This allows us to characterize in a richer way than the previous literature which countries, if any, reap large gains from financial integration.[2] It also opens

[2]Recent contributions by Angeletos and Panousi (2011) and Corneli (2010) are the closest to ours: they investigate how financial integration can affect the steady-state as well as the transition dynamics in a model with uninsurable idiosyncratic entrepreneurial risk. See also Mendoza et al. (2007, 2008) in the presence of idiosyncratic income risk. However, in absence of aggregate risk, they cannot explore the gains from

the door to more precise empirical investigations. We believe our framework is particularly well suited to study the integration of a set of (potentially large) emerging markets that face larger aggregate risk and tend to be on average capital scarce. Importantly, it allows for general equilibrium effects, which we believe can be important since historically liberalization episodes tend to occurs by waves, with a set of countries integrating simultaneously.[3]

Our main findings are that financial integration has very heterogeneous effects depending on the stochastic structure of shocks, the size of countries and their initial degree of capital scarcity. Interestingly the consumption profiles of countries undergoing financial integration are very diverse and potentially non monotonic over time. When looking at welfare, we find that financial integration does not bring sizable benefits to any plausibly parameterized country in the context of the neoclassical stochastic growth model, particularly so for the typical emerging country. In our calibration with a moderate degree of risk aversion, we obtain at most a permanent increase in consumption of 0.5%. The intuition can be summarized as follows. Relatively safe (typically developed) countries have small gains from reducing consumption volatility as calculated in Lucas (1987). They also have small gains due to a more efficient world allocation of capital after integration, as calculated in Gourinchas and Jeanne (2006). Emerging and developing countries face higher levels of uncertainty (Pallage and Robe (2003), Aguiar and Gopinath (2007)) and could have potentially larger gains when they share risk. However, financial integration, by affecting the distribution of risk across countries, also leads to a change in the value of the steady state capital stocks. Unless riskier countries are also capital scarce, they will see capital flowing out and output falling as their precautionary savings are reallocated towards safer (developed) countries and their steady state level of capital stock is lower in the integrated economy. This reallocation of capital reduces their welfare gains from integration. When riskier countries are also significantly capital scarce (as emerging countries in the data), the standard efficiency gains driven by faster convergence are strongly dampened by the reallocation of precautionary savings across countries. Our

consumption smoothing through international risk sharing.

[3]Most emerging markets opened up to financial markets in the late eighties-early nineties. See Appendix B for liberalization dates of emerging countries.

findings thus qualify in an important way the conventional wisdom that emerging countries should face larger gains from financial integration since they face more volatile business cycles. They also significantly differ from the international risk-sharing literature, which would, in the context of endowment economies, typically predicts much higher gains for riskier countries. Our baseline calibration relies on parameters values for risk aversion and levels of risk in line with the business cycles literature but at the expense of counterfactually low risk premia. In an alternative calibration, we show that increasing the market price of risk and risk premia (by increasing risk aversion using non-expected recursive utility, Epstein and Zin (1989), Weil (1990)) generates higher welfare gains from financial integration but the same logic applies: higher gains from risk sharing for volatile countries are dampened by an even stronger capital reallocation towards safer countries.[4] Gains for riskier (emerging) countries are below 0.5% of permanent consumption. In a world with higher market price of risk, safer countries actually benefit the most from financial integration with riskier countries as their permanent increase in consumption reaches 1%. Safer countries can sell insurance at higher price and benefit from a fall in the world interest rate upon integration.

From a methodological point of view, the paper innovates along some major dimensions. An accurate welfare assessment requires a 'global solution' for the model along the transition path as well as around the steady-states. Standard approximation methods based on perturbation or log-linearization around deterministic steady-states (see Judd (1998)) are not appropriate. First, with incomplete markets, net foreign assets are very persistent and the dynamics of the model can drift away from the point of approximation, casting doubt on the accuracy of the approximation. Second, and as importantly, the steady state should depend on the risk sharing opportunities of agents due to the presence of precautionary savings so that we should focus on *risky steady-states* and not deterministic ones (see Coeurdacier, Rey and Winant (2011)). Because financial integration modifies the ability to smooth shocks, it has a first order effect on the steady-state. We build on Krueger and Kubler (2004) (see also Judd, Kubler and Schmedders (2002) and Kubler and Schmedders (2003)) to develop

[4]In such a context, convergence gains for capital scarce emerging countries are also even more severely dampened as the reallocation of precautionary savings dominates.

‘global methods’ necessary for the welfare evaluation of financial integration in a two-country stochastic model with incomplete markets. The algorithm is based on iteration on the policy function, where the policy function is approximated by products of polynomials over a grid of current state variables. At each stage of the algorithm, optimality and market clearing conditions gives values for prices, quantities and the future states at each point of the grid. Outside the grid, interpolation is used. Then, ‘time-iteration’ on the policy function gives the policy function at each point of the grid, using the ‘previous’ policy function for future controls in the Euler equations. We believe the method captures well non-linearities over the state space, can deal with large shocks and/or high risk premia. A standard discretization of the shock process (Rouwenhorst (1995)) allows us to reduce the state space and overcome, at least to a certain extent, the curse of dimensionality.

From an empirical perspective, no clear evidence emerges so far from the literature regarding the effect of financial integration on growth and risk sharing. Eichengreen (2002), Kose et al. (2006), Obstfeld (2009) and Jeanne et al. (2012) provide excellent surveys of the hundreds of papers analyzing the effect of financial integration on growth. Overall, we can safely argue that the evidence is mixed, ranging from no effects on growth (Rodrik (1998)) to moderate effects of at most 1% per year following the liberalization of financial flows (see Bekaert, Harvey and Lundblad (2005) and Quinn and Toyoda (2008) for recent evidence). Similarly, empirical results pertaining to the impact of financial integration on risk-sharing across countries are also very mixed. Our theoretical results show that the effect of financial integration on the growth and the welfare of countries is very heterogeneous (across countries and over time) depending in particular on risk characteristics and a number of other conditioning variables. Such heterogeneity can explain the difficulties of the empirical literature which, by focusing on the *average* effect of financial integration, could not reach a conclusive answer. We also emphasize how taking into account general equilibrium effects can yield different growth and welfare implications compared to the financial integration of a small open economy. The large body of empirical studies implicitly assumes that a small country integrates to the rest of the world independently of others, a fairly strong assumption as groups of (potentially large) countries have historically integrated simultaneously. Our findings may thus help explain why the enormous body of empirical work on financial integration has so far to a large extent failed to produce robust results.

The paper is organized as follows: Section 2 develops our baseline model of financial integration and describe briefly our solution methods. Section 3 presents our main theoretical findings regarding the growth impact of financial integration, the dynamics of consumption and net foreign assets in our stochastic environment. Section 4 evaluates quantitatively the welfare benefits of financial integration. Section 5 provides robustness checks of our findings, performing sensitivity analysis with respect to the specification of shocks, asset markets structures and market sizes. Section 7 concludes.

2 A baseline model of financial integration

We consider a two-country model neoclassical growth model with aggregate uncertainty. Countries can be asymmetric in three dimensions: the aggregate risk they are facing, their initial level of capital and their size. This allows us to analyze the benefits of financial integration in terms of gains from capital accumulation due to capital scarcity as well as gains from risk sharing. We can then study how these gains are distributed across countries when countries are heterogeneous.

In our baseline model, we consider an incomplete market set-up where countries are allowed to trade in a riskless bond only. This regime of financial integration is compared to a benchmark model where countries stay under financial autarky. We believe this incomplete markets environment is more realistic since we focus our attention on the liberalization episodes of emerging markets. At the time of their financial integration in late eighties-early nineties, capital flows were mostly driven by intertemporal borrowing and lending (Kraay et al. (2005)).[5] In robustness checks (see Section 5), we consider the alternative case of complete financial markets to provide some upper-bounds of the benefits of integration.

[5]Portfolio equity home bias is also very extreme for emerging markets, even nowadays, as recently pointed out in Coeurdacier and Rey (2013).

2.1 Set-up

The world is made of two countries $i = \{h, f\}$. There is one good (numeraire) used for investment and consumption. Each country starts with an initial capital stock $k_{i,0}$.

Technologies and capital accumulation. Production in country i uses capital and labor with a Cobb-Douglas production function:

$$y_{i,t} = A_{i,t}\left(k_{i,t}\right)^{\theta}\left(l_{i,t}\right)^{1-\theta} \tag{1}$$

where $A_{i,t}$ is a stochastic level of total factor productivity; $\log(A_{i,t})$ follows an $AR(1)$ process such that $\log(A_{i,t}) = (1-\rho)\log(A_{i,0}) + \rho\log(A_{i,t-1}) + \epsilon_{i,t}$ with $\epsilon_t = \binom{\epsilon_{h,t}}{\epsilon_{f,t}}$ is an i.i.d process normally distributed with variance-covariance matrix $\Sigma = \begin{pmatrix} \sigma_h^2 & \zeta\sigma_h\sigma_f \\ \zeta\sigma_h\sigma_f & \sigma_f^2 \end{pmatrix}$. $A_{i,0}$ is the initial level of productivity in each country which proxies in our simulations for country size.

The law of motion of the capital stock in each country is:

$$k_{i,t+1} = (1-\delta)k_{i,t} + k_{i,t}\phi\left(\frac{i_{i,t}}{k_{i,t}}\right) \tag{2}$$

where $0 < \delta < 1$ is the depreciation rate of capital and $i_{i,t}$ is gross investment in country i at date t. $\phi(x)$ is an adjustment cost function defined as follows for country i:

$$\phi\left(x\right) = a_1 + a_2\left(\frac{x^{1-\frac{1}{\xi}}}{1-\frac{1}{\xi}}\right)$$

a_1 and a_2 are chosen such that at the steady-state $\phi\left(\frac{\bar{\imath}}{\bar{k}}\right) = \delta$ and $\frac{\partial}{\partial\bar{\imath}}\left\{\bar{k}\phi\left(\frac{\bar{\imath}}{\bar{k}}\right)\right\} = 1$.

Firms' decisions. Labour and capital markets are perfectly competitive and inputs are rewarded at their marginal productivity. If $w_{i,t}$ denotes the wage rate in country i, we have:

$$w_{i,t}l_{i,t} = (1-\theta)\,y_{i,t} \tag{3}$$

Capital owners are also paid their marginal productivity of capital $r_{i,t}$:

$$r_{i,t}k_{i,t} = \theta y_{i,t} \tag{4}$$

Preferences. Country i is inhabited by a representative household with Epstein-Zin preferences (Epstein and Zin (1989), Weil (1990)) defined recursively as follows in country $i = \{h, f\}$:

$$U_{i,t} = \left[(1-\beta)c_{i,t}^{1-\psi} + \beta\left(E_t U_{i,t+1}^{1-\gamma}\right)^{\frac{1-\psi}{1-\gamma}}\right]^{\frac{1}{1-\psi}}. \tag{5}$$

where $1/\psi$ is the elasticity of intertemporal substitution (EIS) and γ the risk aversion coefficient. This specification nests the CRRA case when $1/\psi = \gamma$. This is the case we will first consider. Then, we consider alternative cases where agents are more risk averse than our CRRA baseline, keeping the EIS $1/\psi$ constant: $\gamma \geq \psi$, with γ up to 50.

For simplicity, we normalize population to unity in each country: $l_{i,t} = 1$. Country size is then homogeneous to productivity levels $A_{i,0}$ in our set-up (and not population) but this is irrelevant for our purpose.[6] We also implicitly assume an inelastic labor supply. This will, if anything, tend to increase the gains from international risk sharing by suppressing a margin of adjustment of households following shocks.

Budget constraints, household decisions and market clearing conditions. Budget constraints depend on the assets available for savings decisions which is a function of the degree of financial integration. We consider the two following cases in our baseline: (i) financial autarky, (ii) financial integration with a non state-contingent bond only.

The stochastic discount factor in country i is defined as:

$$m_{i,t+1} = \beta\left(\frac{c_{i,t+1}}{c_{i,t}}\right)^{-\psi}\left(\frac{U_{i,t+1}^{\psi-\gamma}}{\left[E_t\left(U_{i,t+1}^{1-\gamma}\right)\right]^{\frac{\psi-\gamma}{1-\gamma}}}\right). \tag{6}$$

(i) Financial autarky.

[6] More precisely, it is irrelevant for the model dynamics following integration. When computing welfare gains, these gains must be multiplied by $\frac{l_i}{l_j}$ for country j to be expressed in per capita terms.

Under financial autarky, the only vehicle for savings is domestic capital. A household can therefore either consume or invest in domestic capital stock her revenues from labour and capital. This gives the following household budget constraint:

$$c_{i,t} + i_{i,t} = w_{i,t} + r_{i,t}k_{i,t}.$$

The associated market clearing condition in country i is:

$$c_{i,t} + i_{i,t} = y_{i,t}. \tag{7}$$

Investment decisions in country i satisfies the following Euler equation:

$$E_t\left[m_{i,t+1}\left(\theta\frac{y_{1,t+1}}{k_{1,t+1}}\phi'_{i,t} + \frac{\phi'_{i,t}}{\phi'_{i,t+1}}\left((1-\delta) + \phi_{i,t+1} - \frac{i_{i,t+1}}{k_{i,t+1}}\phi'_{i,t+1}\right)\right)\right] = 1 \tag{8}$$

where $\phi'_{i,t}$.denotes the first derivative of $\phi_{i,t}$ with respect to $k_{i,t}$.

Note that if we abstract from adjustment costs, we get the usual Euler equation:

$$E_t\left[m_{i,t+1}\left(1 + r_{i,t+1} - \delta\right)\right] = 1$$

where $r_{i,t}$ denotes the marginal productivity of capital defined in (4).

(ii) Financial integration: bond-only economy.

We introduce a riskless international bond whose price at date t is p_t and which delivers one unit of good in the next period. Bonds are in zero net supply. The instantaneous budget constraint at date t in country i in presence of bond trading becomes:

$$c_{i,t} + i_{i,t} = w_{i,t} + r_{i,t}k_{i,t} + b_{i,t-1} - b_{i,t}p_t$$

where $b_{i,t}$ denotes bond purchases at date t by country i.

The Euler equation from bond holdings for country $i = \{h, f\}$ is:

$$p_t = E_t\left[m_{i,t+1}\right] \tag{9}$$

Household investment decisions satisfies the same Euler equation as (8) in country $i = \{h, f\}$.

We close the model by noting that goods and bonds market have to clear:

$$b_{h,t} + b_{f,t} = 0 \tag{10}$$

$$c_{h,t} + i_{h,t} + c_{f,t} + i_{f,t} = y_{h,t} + y_{f,t} \tag{11}$$

Definition of an equilibrium. Under autarky, an equilibrium in a given country i is a sequence of consumption and capital stocks $(c_{i,t}; k_{i,t+1})$ such that individual Euler equations for investment decisions are verified (Equation (8)) and goods market clears (Equation (7)) at all dates.

Under financial integration, an equilibrium is a sequence of consumption, capital stocks and bond holdings in both countries $(c_{i,t}; k_{i,t+1}; b_{i,t})_{i=\{h,f\}}$ and a sequence of bond prices p_t such that Euler equations for investment decisions are verified in both countries (Equation (8)), Euler equations for bonds are verified in both countries (Equation (9)), bonds and goods market clears (Equations (10) and (11)) at all dates.

2.2 Solution method

From a methodological point of view, the paper innovates by providing a 'global solution' for the model along the transition path as well as around the steady-states. Standard approximation methods based on perturbation or log-linearizations around deterministic steady-states are not well suited for welfare evaluations. First, with incomplete markets, net foreign assets are extremely persistent (Schmitt-Grohe and Uribe (2003)) and the dynamics of the model can drift away from the point of approximation. This casts doubt on the accuracy of the approximation along the transition dynamics. Second, the steady state depends on the risk sharing opportunities of agents due to the presence of precautionary savings so that we should focus on *risky* steady states and not deterministic ones as in standard perturbation methods. The risky steady-state is the point where state and choice variables remain unchanged if agents expect future risk but shocks innovations turn out to be zero (Coeurdacier, Rey and Winant (2011)). In general, it differs from the deterministic one where agents do not expect any risk in the future. It also differs from the *stochastic* steady-state, which is the state of the economy averaged over an asymptotically stable distribution (Clarida (1987)). In our simulations, risky and stochastic steady-states are however quantitatively very close from each other. We use the concept of the risky steady-state since it allows us to provide better intuitions of the mechanisms at play and to perform meaningful welfare decompositions in Section 4. We now explain the 'global solution methods' we implement to describe the dynamic of the model and perform the welfare evaluations. Further details on the solution method can be found in Appendix A.[7]

2.2.1 Standardization of the model and time-iteration algorithm

We solve the model using the time-iteration algorithm (Judd, Kubler and Schmedders (2002)). This algorithm is theoretically appealing since it illustrates computationally a contraction mapping property of rational expectation behaviour. In single agents models its convergence has been proven to be equivalent to those of the value function iteration (Rendahl (2006)). To our knowledge there is no such proof of convergence in generic two-agents models, even as simple as ours. For this reason the time-iteration algorithm can be seen as a substitute to missing theoretical tools in order to investigate the theoretical properties of our model.

To understand how the algorithm works, it is useful to reformulate the model in a standardized way. Let define the vector of state variables $s_t = \left(A_t^h, A_t^f, k_t^h, k_t^f\right)$ and the vector of optimal controls and prices $x_t = \left(i_t^h, i_t^f, p_t, b_t\right)$. All random innovations are described by an i.i.d. multivariate normal variable $\epsilon_t = \left(\epsilon_t^h, \epsilon_t^f\right)$.

[7]The computer code, with its complete documentation is available upon request. It relies on the BSD-licensed software Dolo distributed at: http://github.com/albop/dolo/

The model is then characterized by two functions f and g such that the transition of states is:

$$s_t = g\left(s_{t-1}, x_{t-1}, \epsilon_t\right),$$

and, from the Euler equations, the optimal controls satisfy:

$$E_t\left[f\left(s_t, x_t, s_{t+1}, x_{t+1}\right)\right] = 0$$

The full listing of equations written with these conventions is given in the Appendix A. Concretely, the transition equations are the transitions for the exogenous shocks, for the capital and for the debt (if any). The optimality equations are those associated to optimal investment and optimal bond trading.

The solution of this problem is a policy function φ such that: $\forall s_t,\ x_t = \varphi\left(s_t\right)$, where φ is the solution of a single functional equation:

$$\forall s_t,\ E_t\left[f\left(s_t, \varphi\left(s_t\right), g\left(s_t, \varphi\left(s_t\right), \epsilon_{t+1}\right), \varphi\left(g\left(s_t, \varphi\left(s_t\right), \epsilon_{t+1}\right)\right)\right)\right] = 0$$

These optimality conditions can be rewritten as follows:

$$E_t\left[f\left(s_t, x_t, g\left(s_t, x_t, \epsilon_{t+1}\right), \varphi\left(g\left(s_t, x_t, \epsilon_{t+1}\right)\right)\right)\right] = 0 \tag{12}$$

It is important to note that, given a future decision rule φ and any state s_t, there is only one optimal control x_t that solves this equation exactly. We can solve for φ using time-iteration as follows. Suppose we assume a policy function $\hat{\varphi}$ that maps all states into all controls: $x = \hat{\varphi}\left(s\right)$. Then, we use $\hat{\varphi}$ to replace the future decision rule φ into (12). This gives optimal controls x_t that solves (12) for a given state s_t: $x_t = \varphi(s_t)$. If $\varphi = \hat{\varphi}$ then φ is the solution of the whole problem. If not, we update our guess for the policy function $\hat{\varphi}$ with φ and we repeat the steps until the two are equal. If the problem is converging, the error $\max_s \left\|\varphi\left(s\right) - \hat{\varphi}\left(s\right)\right\|$ should have an geometric decay.

2.2.2 Practical implementation

In practice, it is not possible to find the optimal control x for all the states s because they are in infinite number. Instead, we choose a finite subset $S = (s_1, ..., s_n)$ of the state-space, and try to find the corresponding controls $X = (x_1, ..., x_n)$. This defines a policy function on the grid $\hat{\varphi}^X$ such that $\forall i \leq n$, $x_i = \hat{\varphi}^X(s_i)$. These values, together with a good interpolation scheme allow us to define the function $\hat{\varphi}$ for all states (and not only on the subset S). This policy function $\hat{\varphi}$ can then be used to evaluate numerically future decisions in all states. Solving equation (12) on the subset S gives the updated policy function on the grid: $x_i = \varphi^X(s_i)$. Through iteration on the policy function $\hat{\varphi}^X$, the successive approximation errors can then be estimated numerically by taking the maximum variation on the chosen grid: $\max_{i \leq n} \left\| x_i - \hat{\varphi}^X\left(s_i\right) \right\|$.

The first step in defining the approximation scheme consists in an discretization of the joint AR(1) process of the productivity shocks. We perform a Cholesky decomposition of the random innovations $\epsilon_{h,t}, \epsilon_{f,t}$. This gives us a lower tridiagonal matrix Ω and two independent i.i.d. Gaussian noises $(\epsilon'_{h,t}, \epsilon'_{f,t})$ whose joint process is defined by a diagonal covariance matrix Σ_d such that $\Sigma_d = \Omega\Omega'$. Let us define:

$$\begin{pmatrix} \log(A'_{h,t}) \\ \log(A'_{f,t}) \end{pmatrix} = \Omega \begin{pmatrix} \log(A_{h,t}) \\ \log(A_{f,t}) \end{pmatrix}$$

Since the autocorrelation coefficient for $\log(A_{h,t})$ and $\log(A_{f,t})$ is ρ, the processes $\log(A'_{h,t})$ and $\log(A'_{f,t})$ are two independent unidimensional AR(1) processes with autocorrelation ρ and conditional variance given by the diagonal elements of Σ_d. We discretize each of them as a three states Markov chain, using the Rouwenhorst method (Rouwenhorst (1995)). We choose the free coefficients so that the resulting Markov chain has the exact same autocorrelation and asymptotic variance as the original continuous process.

The second step consists in choosing boundaries for the continuous states k_h, k_f and b. We study the capital over a wide enough interval, so that we can simulate economies starting with a significant capital scarcity while capturing the potentially larger capital stocks under autarky or integration. We set the same bounds for both countries $[k_{\min}, k_{\max}] = [1, 10]$.[8] We bound debt values using a condition of the form: $-\bar{b} \leq b \leq \bar{b}$ where $\bar{b}$ denotes exogenous debt limits. Since, we do not want our solution to be dependent on an arbitrary $\bar{b}$, we perform robustness checks with higher/lower debt limits. Inside these boundaries, we discretize each continuous states using 50 evenly distributed points. The resulting grid has $50 \times 50 \times 50$ for the continous states and $3 \times 3 = 9$ points for the discrete one. This makes a total of 1125000 points at which we solve for the optimal controls at each iteration step.

For each value of the markov chain of the productivity process, we approximate the controls by projecting them on a 3-dimensional tensor base of natural cubic B-splines. We use this interpolation scheme to interpolate future controls at future states that are not on the initial grid. To evaluate future controls on a state which is outside of the boundaries, we project this state on the boundaries, compute the values and the derivatives of the controls and use them to extrapolate along each dimension. This is legitimate given that natural splines have zero second order derivatives at the boundaries along each dimension. In practice, this affects only occurrences with very large debt levels since capital is never extrapolated.

3 Growth and consumption dynamics in a risky world

The model outlined in the previous section is a two country version of the stochastic neoclassical growth model. As a well established benchmark in the psyche of the economist profession and of the policy makers, it underpins implicitly the widely heard qualitative claims that financial integration improves capital allocation efficiency and enables better risk sharing across countries. Ironically may be, since they have been very influential in the policy world, those claims have not so far been evaluated in a quantitative version of the model due to the technical difficulties of modelling aggregate uncertainty and production in open economy settings. We now turn to this undertaking.

[8]As a mean of comparison, the deterministic steady-state levels of capital are respectively 2.32, 2.92 and 3.68, when the productivity shocks stays constant at its lower, medium and high level.

3.1 Calibration

Our structural parameters, set on yearly basis, are summarized in Table 1. We use standard values for the discount rate β, the depreciation rate δ and the capital share θ. We first consider the CRRA case and set the the coefficient of risk aversion γ to 4 (Baseline Low Risk Aversion). Macro models typically use a lower value of 2 while the finance literature uses higher values such as 30 or above to generate meaningful risk premia. Note that with CRRA utility, this pins down the elasticity of intertemporal substitution (EIS) $1/\psi$ to 1/4. Our assumed EIS is in the range of estimates in the literature, towards the lower end of the distribution though.[9] Since the risk aversion coefficient turns out to be an important parameter for the quantitative properties of the model and particularly so for the welfare analysis, we also consider higher levels of risk aversion, while keeping the EIS constant to its baseline value of 1/4. To generate reasonable risk premia, we set γ up to 50 in our alternative calibration (Alternative High Risk Aversion). The capital adjustment costs parameter ξ is set to 0.2. In line with the data, this generates a volatility for the rate of investment about two times higher than the volatility of the rate of output growth.

In our baseline calibrations, we focus on countries of equal size by equalizing the initial level of productivity across countries: $A_{h,0} = A_{f,0} = 1$. We do so for two reasons. First, we want to focus on the role played by risk heterogeneity, neutralizing any effect driven by the size of countries. Second, we differ from studies focusing on a small open economy as our main focus is not the financial integration of small countries. In late eighties-early nineties, a large set of emerging markets integrated almost simultaneously (see Appendix B for a list of countries and liberalization dates). These countries account for a large share of world GDP, around 50% in 1990,[10] such that general equilibrium effects cannot be neglected. We will

[9]Most of the empirical literature surveyed in Campbell (2003) finds estimates of the elasticity of intertemporal substitution between 0.1 and 0.5 (see Hall (1988), Ogaki and Reinhart (1998), Vissing-Jorgensen (2002), and Yogo (2004) among others). The macro and asset pricing literature (discussed in Guvenen (2006)) typically assumes higher values between 0.5 and 1.

[10]The total set of emerging countries liberalizing described in Appendix B accounted in 1990 for 97% of the GDP size of (already integrated) developed countries. If we focus only on emerging countries belonging to the main liberalization wave (between 1988 and 1992), they still account for 83% of the size of (already integrated) developed countries. Note that this sample of countries does not include Russia and Central and Eastern European countries due to lack of data for these countries pre-1990. See Appendix B for further

however investigate the importance of size for our results in Section 5.

Discount rate β	0.96
Elasticity of intertemporal substitution (EIS) $1/\psi$	1/4
Relative risk aversion γ	Low RA $=4$ High RA $=50$
Capital share θ	0.3
Depreciation rate δ	10%
Capital adjustment costs ξ	0.2
Relative initial productivity $A_{f,0}/A_{h,0}$	1

Table 1: Parameters values

Stochastic structure. In our baseline simulations, we assume that country f is riskier than country h ($\sigma_h \leq \sigma_f$). Aguiar and Gopinath (2007) provides values for output volatility that are on average twice as large in emerging markets compared to developed countries. In Appendix B, we provide more systematic evidence of the difference in volatility between developed countries and a set of emerging markets which integrated to the world economy since 1985. The average output growth volatility of these liberalizing emerging markets is 4.9% compared to 2.5% in (already integrated) developed countries. Accordingly, in our baseline calibration, σ_h is set to 2.5% to match the average output volatility of developed countries while σ_f is set to 5% to match the output volatility of emerging markets. Thus, we interpret our baseline experiments as the financial integration of a set of emerging countries (in Asia, Latin America...) to a set of developed countries. The persistence of stochastic shocks is set to 0.9. For simplicity, we assume, that productivity shocks are uncorrelated across countries but investigates alternative stochastic structures in Section 5. If anything, such a calibration tends to overstate the gains from financial integration, as risk sharing potential is overestimated. The parameters of the variance-covariance matrix Σ of $(\epsilon_{h,t}, \epsilon_{f,t})$ are summarized in Table 2

details.

for our baseline calibration. Details of the discretization using the Rouwenhorst method are given in Appendix A. When necessary to build the intuition, we compare the baseline case of asymmetric countries with the case of symmetric countries where $\sigma_h = \sigma_f = 2.5\%$.

Persistence parameter ρ	0.9
Volatility σ_h of shocks in country h	2.5%
Volatility σ_f of shocks in country f	5%
Cross-country correlation of shocks ζ	0

Table 2: Baseline stochastic structure

Capital scarcity. The last exogenous parameter is the capital stock in both countries at time of integration. In all our baseline experiments, country h starts at its autarky steady-state. For country f, we use two different values for $k_{0,f}$: (i) f starts also at its autarky steady-state; (ii) f is significantly capital-scarce, its initial capital stock being 50% of the initial capital stock of country h. This choice for capital scarcity is well justified regarding the set of emerging markets which opened financially since 1985. Their capital-output ratio at time of opening is on average 62% of the one of (already integrated) developed countries, where capital is measured using a perpetual inventory method. With a usual Cobb-Douglas production function, this corresponds to a level of capital per efficiency units in emerging markets equal to 52% of the one of developed countries (see Appendix B for details).

This allows us to compare the welfare gains from integration when incorporating the standard neoclassical gains due to initial capital scarcity. We will also discuss welfare gains in the case where the risky country turns out to be capital abundant initially although this is less relevant for the set of countries which integrated to financial markets since the mid-eighties.

3.2 Baseline simulations

We briefly recall the predictions of the neoclassical growth model with respect to financial integration in a non stochastic environment. In partial equilibrium analyses, countries, modeled as small open economies which display different degrees of capital scarcity, do not impact the riskless world rate of interest when they integrate financially. They will import capital if their autarky interest rate is above the world rate of interest, which will be generally the case if they are capital-scarce emerging markets. Upon integration, their time profile of consumption is perfectly smoothed, investment jumps up so that capital accumulation speeds up. The country borrows internationally to fulfil its optimal consumption and investment plans. Capital flows from 'low marginal product of capital countries' (the rich world) to 'high marginal product countries' (emerging markets). As shown by Gourinchas and Jeanne (2006), financial integration brings welfare gains at it speeds up capital accumulation towards the steady state capital stock, pinned down by the exogenous world rate of interest. Quantitatively, these gains are found to be small (of less than 1% increase in permanent consumption for realistic degrees of capital scarcity and at most 2%), a reflection of their transitory nature.

3.2.1 A riskless world: the role of capital scarcity

Experiment 1: A riskless world in general equilibrium.

Figure 1 shows the dynamics of macro variables in a non stochastic environment.[11] Compared to the experiments in Gourinchas and Jeanne (2006), we relax the small open economy assumption, i.e. the world rate of interest after financial integration is endogenously determined.

The environment is entirely symmetric except that one of the country starts off being 50% capital scarce, while the rest of the world starts at its autarky steady state. The upper panel of Figure 1 shows the capital and consumption transition paths for developed country as well as interest rates. The lower panel shows the capital and consumption transition paths for the capital scarce country as well as the net foreign asset over GDP of the developed country. Dashed lines refer to autarky levels while plain lines refer to levels after integration. Like in the small open economy example, gains to financial integration comes from the capacity

[11]Simulations are performed with an EIS ψ equal to its baseline value of $1/4$. The degree of risk aversion is irrelevant in this case.

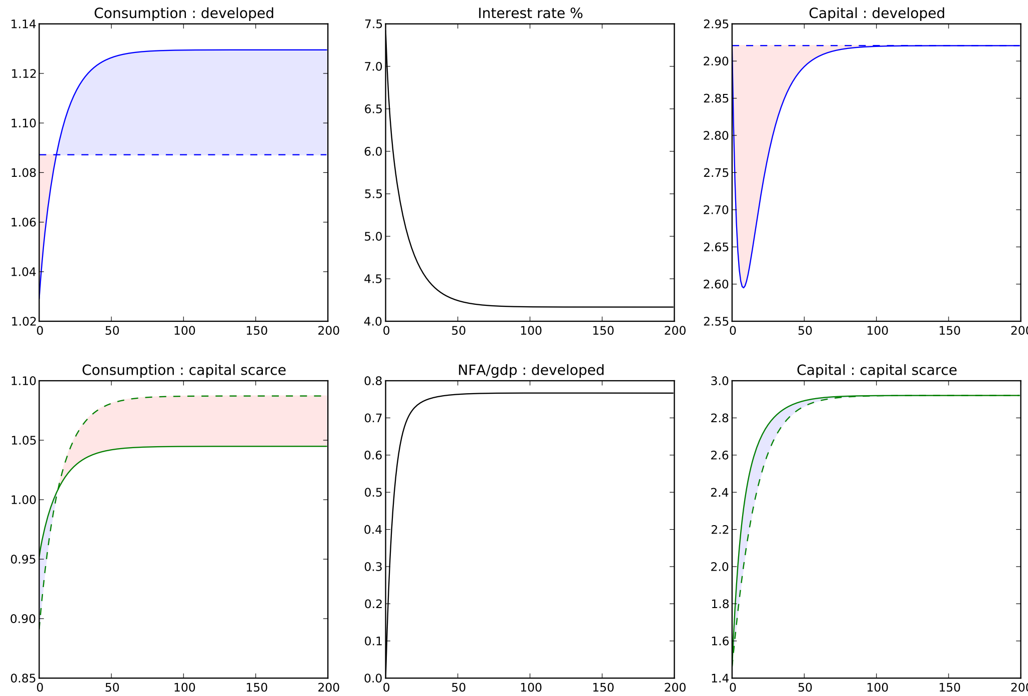

Figure 1: Dynamics along the deterministic path in Experiment 1.

Notes: Parameters of the model are shown in Tables 1 and 2 (risk aversion is irrelevant in the absence of risk). Countries are symmetric except for initial capital stock. The capital scarce country is endowed at the date of integration with 50% of the autarkic steady-state capital stock while the developed economy starts at its steady state. There is no uncertainty. Dotted lines (resp. solid lines) refer to autarky levels (resp. levels under integration).

of the capital scarce economy to borrow in order to speed up capital accumulation to reach its steady state level of capital stock. Unlike in the small open economy case, consumption is not constant over time and the debt level is not as high. In the general equilibrium case, welfare gains of financial integration are shared between the country and the rest of the world. While in the partial equilibrium case welfare gains of the capital scarce economy amounts to 1.03% of consumption in this case, in the general equilibrium case, where the interest rate is endogenously determined the country gains 0.38% of consumption and the rest of the world 0.29% only. Hence, not taking account of general equilibrium effects leads to an *overestimation* of the neoclassical gains from financial integration.

3.2.2 A risky world: Capital scarcity and risk sharing effects

We now turn to the richer predictions of the stochastic model, focusing on the interactions between the risk sharing motives and the effect of integration on capital accumulation. To our knowledge, these interactions, which materially affect the predictions of the model with respect to consumption and investment have never been studied in the literature.

Risky steady-states. The steady state of the model depends on the risk sharing opportunities of agents due to the presence of precautionary savings (Coeurdacier, Rey and Winant (2011)). As financial integration modifies the ability to smooth shocks, it has a first order effect in the long-run by modifying the steady-state towards which the economy is converging. Under autarky, countries converge to a steady-state described in the first panel of Table 3 in the CRRA case (Baseline low risk aversion with $\gamma = \psi = 4$, Top Panel) and in the Epstein-Zin case (High risk aversion with $\gamma = 50; \psi = 4$, Bottom Panel). The difference in volatility is the only (long-run) asymmetry built in the model. If countries only differ by the level of aggregate risk they are facing, the riskier country f ends up accumulating more capital and producing more output in its autarky steady-state. This is due to the presence of higher precautionary savings in that country. Higher precautionary savings also depress the interest rate in country f. In our framework, risk matters for the steady-state of the economy since higher level of risk drives up savings and foster capital accumulation in the riskier country. Our *risky* steady-state is thus different from the deterministic steady state that is usually explored in standard neoclassical growth models. This risky steady state is the steady-state where the economy stays in presence of risk but when shocks innovations are zero.[12] With a fairly low level of risk aversion and risk twice as big in country f, the model already generates a noticeable difference in the steady-state level of capital across countries under autarky. As shown in the top panel of Table 3, the riskier country f ends up with a level of capital stock which is 4% higher than the safer country. Note that with a higher level of risk aversion ($\gamma = 50$), precautionary savings increase and differences in autarkic steady-states level of capital are much larger: under autarky, the riskier country ends up having a capital stock 26% higher (bottom panel of Table 3).

Under financial integration (bond only), the steady-state level of capital converges across

[12]For a more detailed analysis of the risky steady state. See Coeurdacier, Rey and Winant (2011) and Juillard (2012).

Low risk aversion ($\gamma = 4$)				
Autarky				
	Capital k	Output y	Riskless rate $1/p - 1$	$\frac{\text{Net foreign assets}}{\text{Output}}$
Country h	2.96	1.38	3.93%	0
Country f	3.08	1.40	3.27%	0
Financial integration (bond only)				
	Capital k	Output y	Riskless rate $1/p - 1$	$\frac{\text{Net foreign assets}}{\text{Output}}$
Country h	2.97	1.39	3.89%	−275%
Country f	2.95	1.38	3.89%	275%
High risk aversion ($\gamma = 50$)				
Autarky				
	Capital k	Output y	Riskless rate $1/p - 1$	$\frac{\text{Net foreign assets}}{\text{Output}}$
Country h	3.34	1.44	2.11%	0
Country f	4.20	1.54	−1.77%	0
Financial integration (bond only)				
	Capital k	Output y	Riskless rate $1/p - 1$	$\frac{\text{Net foreign assets}}{\text{Output}}$
Country h	3.60	1.47	1.43%	−171%
Country f	3.34	1.44	1.43%	171%

Table 3: Risky steady-state values.

Parameters of the model are shown in Tables 1 and 2. Top panel: Baseline with low relative risk aversion. Bottom panel: Baseline with high relative risk aversion. Countries are symmetric except for risk with $\sigma_f = 2\sigma_h$.

countries as the riskless rate is equalized across borders. Note however that in the integrated steady state, capital stocks are not fully equalized countries. The riskier country f ends up with a permanently lower stock of capital than the safer country h. This is so because the risk premium on capital remains higher in f due to higher volatility. In other words, contrary to autarky, the cost of capital in f is above the one in h: the increase in the riskless rate in

f dominates the fall in risk premia. The difference between the two capital stocks remains however quantitatively very small in this environment with small risk premia. With a high degree of risk aversion ($\gamma = 50$), the difference is more significant and the risky country ends up with a capital stock under integration about 8% lower than the safe country due to higher cost of capital.[13] The reason is that financial integration brings significant risk-sharing opportunities, despite markets remaining incomplete. As both countries can smooth consumption better following productivity shocks, they enjoy gains from risk sharing, precautionary savings decline and the world steady-state capital stock falls. Consequently the riskier country ends up producing less under financial integration than in the autarkic steady-state. The opposite holds for the safer country. The riskier country turns into a net lender in the steady-state as it gets rid of some of his risk by holding a positive net foreign asset position. The safer country is willing to hold that risk by having a leveraged position since it faces a lower amount of aggregate risk on its labor and capital income. Contrary to what is obtained with local approximations around a deterministic steady-state (see Schmitt-Grohe and Uribe (2003)), our global solution pins down a stationary cross-country distribution of wealth. In the long term, there is a stable level of debt associated with the equilibrium world rate of interest. Intuitively, the accumulation of net foreign assets by the riskier country is less attractive once his 'buffer stock' of precautionary savings is reached. However convergence towards this stationary distribution is slow and this stabilizing effect has negligible implications in short/medium run as shown in the next experiments. In our baseline calibrations, we insist on the risky steady states in presence of heterogeneous levels of risk but one should also note that when the two countries are equally risky, financial integration still enables them to share their aggregate risk. This reduces the need for precautionary savings in both countries and leads to a lower steady state level of capital stocks and outputs. This simple discussion highlights the two forces that are at play within our model when financial integration takes place: integration enables better risk sharing and at the same time it affects the steady state level of capital

[13] In our model, the riskier (emerging) country has a higher steady-state capital stock in autarky which might appear counterfactual. But this is true *only* at the steady-state for which there is potentially no empirical counterpart. In the data, at time of opening, emerging markets were indeed significantly capital scarce (see Appendix B). Under integration, the riskier country has a lower steady-state capital stock.

stock as precautionary savings adjust to the new environment. As a result the speed of capital accumulation, associated to the neoclassical gains to financial integration, is also altered.

We now turn to the description of the transitory dynamics following financial integration. We start with the CRRA case (Baseline low risk aversion, with $\gamma = 4$).

Experiment 2. A risky world: growth and capital flows dynamics along the risky path, starting at the (autarky) risky steady-state.

In this experiment, we focus on the impact of risk differences across countries. Unlike in the previous non stochastic experiment depicted in Figure 1, the two countries start at their autarky steady state such that (long-run) changes in capital stocks are only due to changes in steady-states following integration. In Figure 2, we plot the dynamic of consumption, capital, interest rate and net foreign assets following financial integration in period zero, for the risky f and the safe h country with $\sigma_f = 2\sigma_h = 5\%$ in the baseline low risk aversion case. These dynamics are taken along the path where the realization of innovations are zero. To be consistent with our risky steady state definition, we will refer to this path as the *risky path*. Risk is taken into account along that path since agents expect stochastic shocks even though innovations are zero along the path.

The upper panel of Figure 2 describes the paths of consumption and capital for the safe economy while the lower panel pertains to the risky economy. Both countries start from their autarky steady-state. Dashed lines represent autarky variables while plain lines represent post integration variables. The riskier economy lends to the safe economy (positive net foreign asset positions of the riskier economy). This is so because the riskier country f has a lower autarky interest rate, reflecting a higher degree of precautionary savings. Upon financial integration the riskier country reduces its capital stock, exporting capital towards the safer economy, whose autarky interest rate is higher. Conversely, the safer economy increases its capital stock once financial integration takes place. The dynamic is driven by the change of risky steady-states caused by financial integration. The world rate of interest reflects the level of risk in the integrated world economy. Hence, in our framework, *heterogeneity in risk* generates

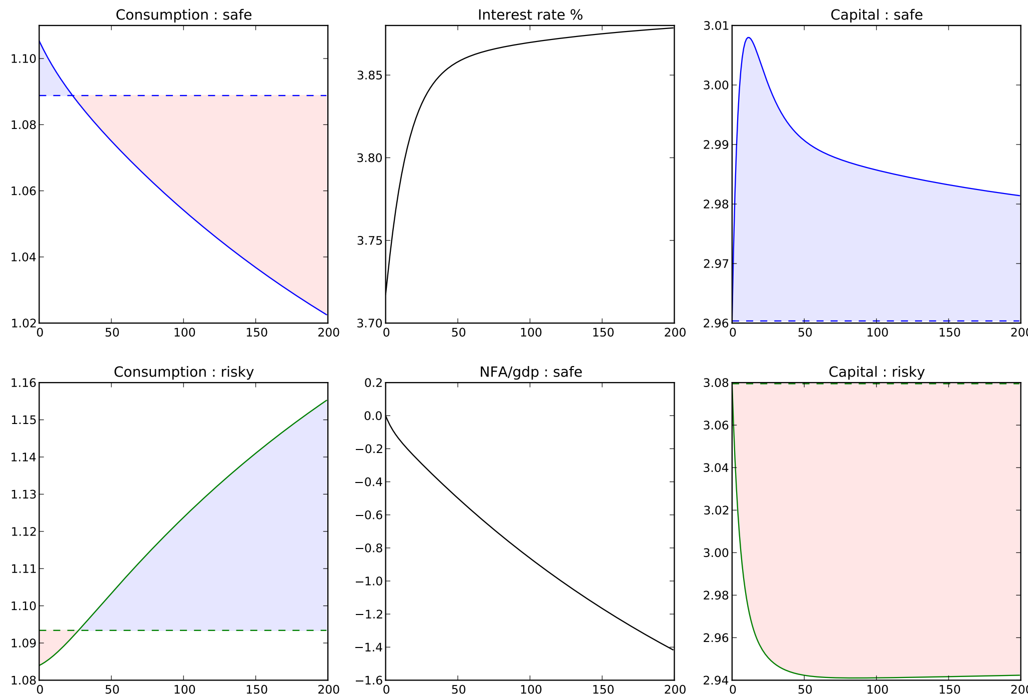

Figure 2: Dynamics along the risky path in Experiment 2.

Notes: Parameters of the model are shown in Tables 1 and 2 where relative risk aversion is set to 4. Countries are asymmetric in terms of risk with $\sigma_f = 2\sigma_h$. Countries start from their autarky risky steady states. Dotted lines (resp. solid lines) refer to autarky levels (resp. levels under integration).

a divergence in growth rate across countries when financial integration occurs. The effects are modest (0.12% fall in growth for the riskier country on impact) but comparable in magnitude to the standard neoclassical growth impact of financial integration when countries are capital scarce (Gourinchas and Jeanne (2006)). Contrary to Experiment 1, changes in capital and output are also permanent.

In order to increase its capital stock while still smoothing consumption, the safer country runs current account deficits and its net foreign asset position turns negative. It enjoys higher consumption than in the steady-state. Once it has converged towards its steady-state, country h runs current account surpluses corresponding to the foreign debt repayments. Its consumption is permanently lower than output. The riskier country f reduces consumption at opening to accumulate foreign assets, enjoying higher consumption in the longer-term when country h pays back its debt. Such a dynamic implies asymmetric gains from financial integration along the transition path. In particular, in the short-run, country h enjoys significantly higher benefits than country f.

Experiment 3. A risky world: growth and capital flows dynamics along the risky path with some initial capital scarcity.

We now turn to our benchmark simulations. This experiment corresponds to the financial integration of a *large*, *risky* and *capital scarce* (emerging) country f to a safe (developed) country h and thus resembles the liberalization episode of a set of emerging markets in the late eighties-early nineties. We first stick to the CRRA calibration, keeping risk aversion to its low level.

When a country is away from its autarky steady-state, it will benefit from financial integration as this will foster convergence, like in the non stochastic model. But the key new aspect is that the steady-state towards the country is converging is *also changing with financial integration*. Since the growth rate of output depends on how far the country is from its steady-state, two forces are at play, the *capital scarcity* effect and the *risk sharing* effects which alters the desirability of precautionary savings.

For country f, our emerging market style economy which is both capital scarce and volatile, these two forces will be conflicting, as displayed in Figure 3. As before, dashed lines represent autarky variables while plain lines represent post-integration variables. One the one hand, capital scarcity implies faster convergence and faster growth upon financial integration compared to autarky. On the other hand, since the steady-state level of capital stock and output of the riskier country decreases with integration, the country is upon opening *closer* to its steady-state. This implies a lower rate of output growth compared to financial autarky. Which effect dominates at a given date depends on the level of capital stock in the country and in particular its distance to its autarky steady-state value. If country f is sufficiently capital scarce as in our Experiment 3 (country f's initial capital stock is half of the one in country h), the capital scarcity effect dominates and financial integration leads to a growth acceleration in the capital scarce country. This acceleration is however muted compared to the deterministic case.[14] As time passes and the capital scarcity effect dissipates, growth slows down and the dominant effect is the risk sharing one: the long-run capital stock of the risky country being smaller in the integrated economy than in autarky, growth is lower under integration than in autarky.

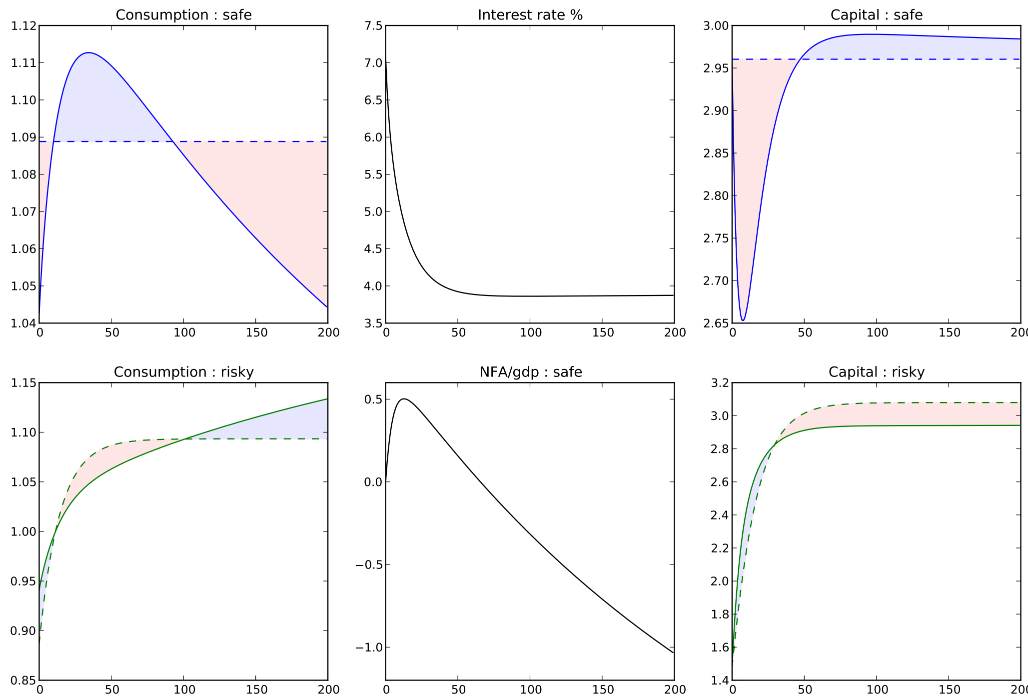

Figure 3: Dynamics along the risky path in Experiment 3 with low risk aversion.
Notes: Parameters of the model are shown in Tables 1 and 2 (baseline with low risk aversion $\gamma = 4$). Countries are asymmetric in terms of risk with $\sigma_f = 2\sigma_h$. Initial capital stock of the risky country f is at 50% of the one in the safe country h. Safe country starts at its autarky steady-state. Dotted lines (resp. solid lines) refer to autarky levels (resp. levels under integration).

Regarding the safer country h which starts at its autarky steady-state, two forces are also at play: first, its growth rate tends to fall since resources are allocated to the country with the highest marginal productivity of capital, i.e. country f. Second, the growth rate of country h tends to pick up since it enjoys a higher steady-state level of output as it integrates with a more volatile economy. Due to decreasing marginal productivity of capital, the first effect (capital abundance effect) dominates on impact while the second one (risk sharing effect) dominates

[14]In another experiment not shown where capital scarcity is less important (country f being 15% away from country h's capital stock), country f is growing at a slower pace compared to autarky at the date of integration.

when country f is getting closer to its steady-state. Interestingly, country h exhibits growth and consumption reversals due to financial integration (see upper panel of Figure 3).[15]

We believe our experiment illustrates the heterogenous effects of financial integration on output growth, heterogenous effects across countries as well as over time. Depending on the degree of heterogeneity across countries in capital scarcity and in the level of aggregate risk, output responses to financial integration can be fairly different. The empirical literature has been mostly trying to identify an *average* effect of financial integration on growth, leaving aside potential heterogeneous responses (see Kose et al. (2009) for a recent survey). Empirical estimates vary significantly across studies (across countries samples and sample periods) and tend to be fairly low, at most 1% increase in growth on impact. Our theory forms the basis of a rationale for such heterogeneity in the empirical estimates. Moreover, the empirical literature often tries to identify the growth impact of the financial integration of an individual emerging country. While taken individually, most emerging countries are small, they have historically integrated over the same time frame. This makes it likely that their integration impacted the world interest rate. With adverse general equilibrium movements of world interest rates as in all our Experiments, the growth effects of financial integration can be severely dampened in emerging markets. Beyond the cross-country heterogeneity in responses, this could also partially explain why empirical estimates of the growth effects of financial integration are found to be low.

When considering international capital flows, similar conflicting forces are at play: on one side, country f tends to have a higher marginal productivity of capital at opening and is willing to borrow internationally to finance capital accumulation. On the other side, he is willing to lend internationally for self-insurance due to its higher level of risk. When country f is further away from its autarky steady-state, the capital scarcity effect dominates and country f tends to run current account deficits. As it converges, the risk sharing effect starts to dominate and country f starts running current account surpluses. In the long-run, the

[15] In an experiment not shown (when country f is only 15% away from its autarky steady-state at opening), it is interesting to notice that financial integration is on impact growth reducing for *both* countries due to a worlwide fall in precautionary savings.

countries intertemporal budget constraint imposes that country f, which ends up as a net lender, runs current account deficit financed by foreign debt payments of country h. Hence, our model exhibits capital flow reversals along the transition path. Quantitatively, in the experiment where country f starts 50% away from its autarky steady-state, it starts running a current account deficit of 14.5% of its GDP immediately after opening, then moves into surplus of roughly 4% of GDP (attained after three decades) before moving back again much later into a current account deficit as country h starts to repay its accumulated foreign debt.

We now consider the alternative calibration under non-expected utility, setting the risk aversion γ to the value of 50 (Alternative high risk aversion). The experiment is the exact same one up to the difference in risk aversion and thus market price of risk. Our baseline calibration with CRRA utility relies on a moderate risk aversion. One could object that our results rely on a counterfactually low of risk premia on the capital stock (risk premia are 0.10% in the safe country and 0.39% in the riskier country under autarky, and even smaller under financial integration since consumption becomes smoother). This is so because both consumption risk and the level of risk aversion are fairly small. At this stage, one way to get higher risk premia is to crank up the level of risk aversion up to 50, as commonly done in the finance literature.[16]

Figure 4 shows the main variables of interest following integration in the case of our benchmark Experiment 3 but with $\gamma = 50$ (the risky country still starting with 50% of the safe country's capital stock). The dynamic is quantitatively altered compared to the previous experiment with low risk aversion but our main message goes through. The intuitions are the same and we insist on the differences in terms of growth dynamics. Quantitatively the effects driven by the reallocation of precautionary savings are amplified. At time of opening, the riskless rate fall significantly more in the borrowing (safe) country h compared to our previous experiment as the risky country has a strong demand for safe assets. The safe country benefits more from this large positive movement in its 'terms-of-trade' and from financial integration.

[16] In a production economy, consumption risk is bound to be small since agents can use the domestic capital to smooth consumption (Jermann (1998)), the reason why we need to set γ to such a high value to generate realistic risk premia.

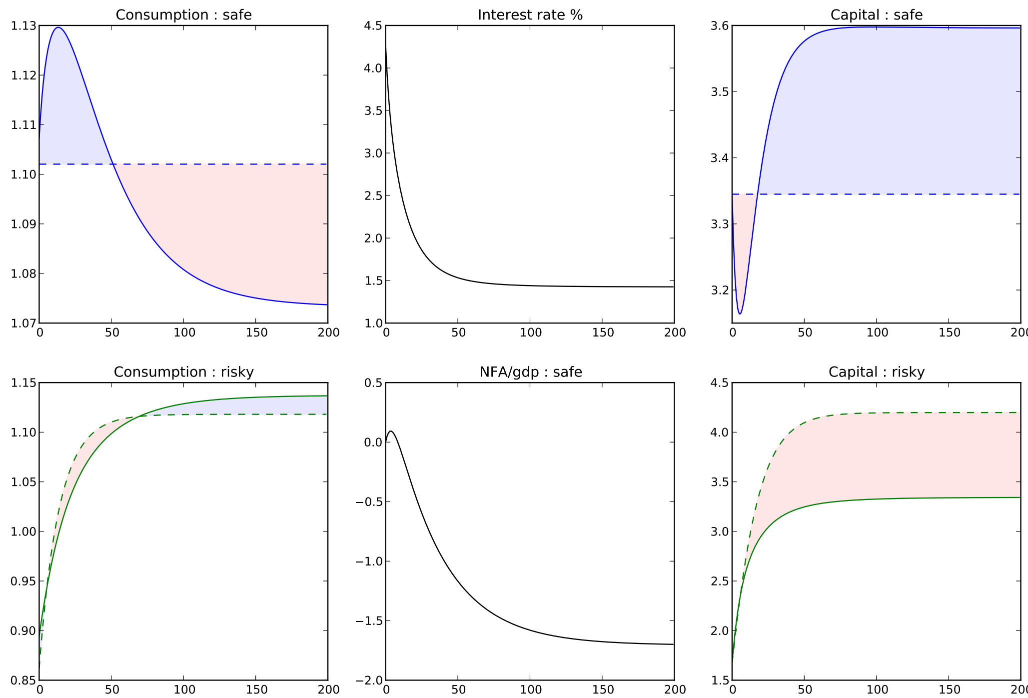

Figure 4: Dynamics along the risky path in Experiment 3 with high risk aversion.
Notes: Parameters of the model shown in Tables 1 and 2 with a high level of risk aversion $\gamma = 50$. Countries are asymmetric in terms of risk with $\sigma_f = 2\sigma_h$. Country h starts at its autarky steady-state. Country f starts with a capital stock equal to 50% of the one in country h.

Capital moves away from the risky country following integration despite its lower level of capital initially. Being capital scarce, the risky country keeps growing but at a slower pace than it would have under autarky. In other words, following integration, the risky country is closer to its steady-state than under autarky: growth slows down. Note that at time of opening, this implies that the risky country is lending significantly more to the safe country h, generating a higher consumption boom (and investment boom) in the latter. Output growth in the safe country decreases by 0.6% following integration compared to a 1% fall in the previous experiment with low risk aversion. The permanent difference in the long-run capital stock between autarky and integration is also quantitatively important when risk premia are large: under integration, country h ends up with capital stock 8% larger while f ends up with a capital stock 20% smaller. [17]

[17] If the country f starts also at its autarky steady-state (Experiment 2 with a high value of γ, not shown), the dynamic is qualitatively preserved compared to our baseline Experiment 2 but the reallocation of precautionary savings being magnified, output falls more at time of integration in the risky country (and conversely increases

4 Welfare analysis

As the previous section shows, if riskier countries are also capital scarce at opening, the effect on output will be ambiguous, depending on two conflicting forces, the standard efficiency gains and the reallocation of precautionary savings towards the safer country. Efficiency gains are reduced since the riskier country will end up with a permanent fall in steady-state output and thus the convergence-gap, essential for these efficiency gains, fall at time of integration. Our findings thus qualify the conventional wisdom that risky and capital scarce emerging countries should face large gains from financial integration. In this section we present quantitative estimates of the welfare gains of financial integration.

Definition of welfare gains. As standard in the literature, we express welfare gains in terms of equivalent increase in permanent consumption compared to autarky. For a given asset market structure (A for autarky or FI for financial integration with bonds in our baseline), let us define the permanent certainty equivalent level of consumption $\overline{c_i}^j$ in country $i = \{h, f\}$ in regime $j = \{A; FI\}$ such that:

$$U_{i,0}^j(\overline{c_i}^j) = E_0(U_{i,0}^j)$$

where $U_{i,0}^j$ is the utility defined recursively in Equation 5 in regime $j = \{A; FI\}$ and $\overline{c_i}^j$ is constant consumption path providing the same expected utility. Thus, the welfare gains from financial integration in % of permanent consumption g_i in country i are defined as:

$$g_i = \frac{\overline{c_i}^{FI} - \overline{c_i}^A}{\overline{c_i}^A}$$

4.1 Welfare gains with constant relative risk aversion

We start by quantifying the welfare gains in our baseline case with low risk aversion and expected-utility (CRRA utility with $\gamma = 4$).

more in the safe country): output growth in the safe country is roughly 1% higher than in the risky country at time of integration.

Efficiency gains and risk sharing gains. To provide further intuitions of the results in the CRRA case, we decompose the welfare gains from integration into 'risky gains' and 'stochastic gains'. Let us define $Rc^j_{i,t}$ the consumption of country i for a given asset market structure $j = \{A; FI\}$ at date t along the risky consumption path. According to our definition, the risky consumption path denotes the path of consumption along which innovations of shocks are equal to zero at all dates.[18]

In the CRRA case, we decompose welfare as follows for $i = \{h, f\}$ and $j = \{A; FI\}$:

$$E_0(U^j_{i,0}) = \underbrace{\sum_{t=0}^{\infty} \beta^t \frac{\left(Rc^j_{i,t}\right)^{1-\gamma}}{1-\gamma}}_{\text{risky}} + \underbrace{E_0 \sum_{t=0}^{\infty} \beta^t \frac{\left(c^j_{i,t}\right)^{1-\gamma} - \left(Rc^j_{i,t}\right)^{1-\gamma}}{1-\gamma}}_{\text{stochastic}}$$

We also introduce $\overline{Rc^j_i}$ which denotes the permanent equivalent level of consumption along the 'risky path' as follows:

$$\sum_{t=0}^{\infty} \beta^t \frac{\left(Rc^j_{i,t}\right)^{1-\gamma}}{1-\gamma} = \frac{1}{1-\beta} \frac{\left(\overline{Rc^j_i}\right)^{1-\gamma}}{1-\gamma}.$$

The *risky* welfare gains g^R_i from financial integration and the *stochastic* gains g^S_i are defined as follows:

$$g^R_i = \frac{\overline{Rc^{FI}_i} - \overline{Rc^A_i}}{\overline{Rc^A_i}} \quad ; \quad g^S_i = g_i - g^R_i$$

The risky welfare gains g^R_i denote the permanent consumption increase following financial integration if the dynamic of consumption of country i follows the risky path all along the transition. Note that $\overline{c_i}^j$ is the permanent consumption in presence of stochastic shocks, while $\overline{Rc^j_i}$ is the permanent consumption along the risky path (in presence of risk but without any shocks). Thus, in country i the costs of consumption fluctuations due to the presence of stochastic shocks are equal to $\frac{\overline{Rc^j_i} - \overline{c_i}^j}{\overline{Rc^j_i}}$.

With a bit of algebra, one can show that the *stochastic* welfare gains g^S_i are proportional

[18] The risky path is different from the deterministic path where the volatility of shocks is set to zero. Along the risky path, individuals make decisions expecting uncertainty.

to the reduction of the costs of consumption fluctuations following financial integration:

$$g_i^S = \left(\frac{\overline{Rc_i^{FI}}}{\overline{c_i}^A}\right) \underbrace{\left(\frac{\overline{Rc_i^A} - \overline{c_i}^A}{\overline{Rc_i^A}} - \frac{\overline{Rc_i^{FI}} - \overline{c_i}^{FI}}{\overline{Rc_i^{FI}}}\right)}_{\text{fall in the costs of stochastic shocks}}$$

Such a decomposition gives insights on the gains in terms of consumption which can be mostly ascribed to efficient capital reallocation (g_i^R) compared to gains which can be mostly ascribed to smoothing shocks over time through risk-sharing (g_i^S). We will thus label g_i^R as efficiency gains and g_i^S as risk-sharing gains. This dichotomy is a bit of an abuse of language since some efficient reallocation of capital occurs following productivity shocks and are included in the stochastic gains (g_i^S). Efficiency gains (g_i^R) includes only gains from capital reallocation along the risky path, i.e coming from the reallocation of precautionary savings and from capital scarcity.

Quantitative evaluation of welfare gains. Table 4 provides a summary of the findings with CRRA utility (Baseline Low Risk aversion). The benchmark case corresponds to Experiment 3, where country f is riskier and capital scarce. The 'no capital scarcity' case corresponds to Experiment 2 (only risk asymmetry). For comparison purposes, keeping all other parameters identical, we also provide results for a case with symmetric countries (symmetric risk $\sigma_h = \sigma_f = 2.5\%$ and identical initial autarky steady-state capital stock, line 3 of Table 4), for endowment economies (infinite capital adjustment costs $\xi \to \infty$, line 4 of Table 4) and for the riskless world model ($\sigma_h = \sigma_f = 0$, line 4 of Table 4). In the latter case, f starts off being capital-scarce ($k_{f,0}$ is 50% of the initial (steady-state) capital stock of h). Thus, it has to be compared to the capital scarce experiment in presence of aggregate risk (Benchmark, line 1 of Table 4).

First and foremost, in our stochastic model with production, gains from financial integration are remarkably small: less than half-a-percent of permanent consumption. This is significantly below estimates in the literature, and thus despite the presence of both types of gains, efficiency gains and gains from international risk-sharing. The main reason for this finding is that gains from capital reallocation (g_i^R) are reduced for countries that benefit the most from risk-sharing (g_i^S) (and vice versa). In other words, gains from the reallocation of capital and gains from risk-sharing are roughly speaking substitutes, which makes it very unlikely to observe large gains from financial integration for any country. The intuition goes as follows: the riskier country benefits the most from risk-sharing, but by allowing him to share output risks better, financial integration reduces its level of precautionary savings, and capital tends to reallocate away from that country. In the case without initial capital scarcity, capital reallocation along the risky path brings welfare losses for that country. If the riskier country is also capital scarce (our benchmark of Exp. 3), capital reallocation brings small gains for both countries: the reallocation of precautionary savings (away from f) offsets partially the gains from capital scarcity (reciprocally by importing capital initially for efficiency reasons, the risky country cannot self-insure optimally, reducing its gains from risk-sharing).

In these experiments with asymmetric risk, the risky country has to pay a price for better insurance, which benefits the safer one. Thus, perhaps counter-intuitively, gains from risk sharing are relatively equally shared, this is true even when the risky country is initially capital scarce. We will show that this finding does not survive in an environment with high risk premium, and if anything the safer country is the main beneficiary from integration (see Section Section 4.2). Note also that in a world with symmetric (but low) risk, aggregate welfare gains are even smaller compared to the cases with asymmetric risk: this should not come at a surprise since similar countries have less incentives to reallocate capital and risk. This significantly lowers the 'gains from trade'.[19]

Regarding the timing of the gains, gains are front loaded by the safer country when the risky country is not capital scarce (Experiment 2). The gains in the short-run are potentially much larger since the safer country enjoys a consumption boom over the first two decades following integration. The opposite holds for the riskier country which significantly cuts consumption in the short-run. Holding risk constant across countries, welfare gains are also

[19] In our symmetric risk case, risky gains are not exactly zero, even without capital scarcity. A drop in world precautionary savings generates some changes in countries capital stocks and some consumption reallocation along the risky path. Effects are very small in the CRRA case though.

	Agg. gains g_i		Risky gains g_i^R		Stoch. gains g_i^S	
	h	f	h	f	h	f
Benchmark (Exp. 3)	0.42	0.53	0.15	0.46	0.27	0.07
No capital scarcity (Exp. 2)	0.29	0.26	0.06	-0.08	0.23	0.34
Symmetric	0.10	0.10	$\simeq 0\%$	$\simeq 0\%$	0.10	0.10
Endowment	0.70	0.67	–	–	–	–
Riskless world (Exp. 1)	0.29	0.38	0.29	0.38	-	-

Table 4: Welfare analysis of financial integration with CRRA utility

Notes: Gains are expressed in % equivalent of permanent consumption. Parameters of the model are shown in Tables 1 and 2 (Low risk aversion calibration with $\gamma = 4$). For the benchmark and 'no capital scarcity' cases, $\sigma_f = 2\sigma_h = 5\%$. For the 'symmetric' case: $\sigma_h = \sigma_f = 2.5\%$ and both countries start at their autarky steady state capital stock. In the riskless world and in the benchmark case, country f is capital scarce (50% of its autarkic capital stock) at date 0. In the endowment case, both countries have the same initial size and adjustment costs to capital are infinite.

front loaded by capital scarce economies. Therefore, in our benchmark (capital scarce country f corresponding to Experiment 3), two forces are at play: on one side, the capital scarcity effect generates short-run consumption gains (resp. losses) for country f (resp. country h). On the other side, the reallocation of precautionary savings towards the safer country generates short-run gains (resp. losses) for country h (resp. country f). When simulating the consumption paths, we find that on average both effects tend to offset each other and both countries have fairly small consumption gains in first twenty years following integration.

The welfare gains from integration are also remarkably higher when considering endowment economies, even if there are efficiency gains due to capital scarcity[20] With endogenous production, gains from international risk-sharing are significantly smaller for both countries because capital can be used in the autarky regime to smooth stochastic shocks. Considering production economies is however at the expense of counterfactually low risk premia, a criticism we tackle in Section 4.2.

[20] This experiment corresponds to the ones run in the international risk-sharing literature (see van Wincoop (1999) and Lewis (1999) for references).

These findings call for a last important comment when comparing them to Gourinchas and Jeanne (2006). In their exercise, Gourinchas and Jeanne (2006) neglects potential losses due to capital reallocation since they focus on a small open economy. Hence, in their set-up, the capital reallocation is not slow-downed by a raise in the world interest rate: the capital abundant country is exporting capital abroad without decreasing its own capital stock. Even in the non-stochastic case, the general equilibrium forces in our model already reduce the welfare gains due to efficient capital reallocation to an order of magnitude smaller. In the first two decades following integration, gains are however significant in the absence of uncertainty for the capital-scarce country, with an increase of 2% of permanent consumption due to faster convergence. In presence of aggregate risk, if the capital scarce country is also the riskier, the reallocation of capital due to the change in the steady-state offsets the standard efficiency gains and welfare gains of country f remains low even in the short-run.

4.2 Welfare analysis with non-expected utility

Our baseline calibration with CRRA utility generates very low risk premia. We now compute welfare gains with recursive utility as defined in Equation 5 cranking up the degree of risk aversion to generate realistic risk premia. To isolate the effect driven by the price of risk, we first compute the welfare gains in the case of Experiment 3 (country f starts off capital scarce), with the risk aversion γ ranging from 4 to 50. Other parameters are kept to their baseline values (see Tables 1 and 2). Estimates of the welfare gains from financial integration for different values of γ are shown in Figure 5.

First, not surprisingly, overall welfare gains from financial integration (i.e the average of the gains across countries) are increasing in the degree risk aversion. This is so because international risk sharing is more valued with higher risk aversion. However, despite a much higher market price of risk (a 2.75% risk premium in autarky in the risky country under autarky for $\gamma = 50$), the welfare gains remain quite small, with an average across countries below 1%.

They are remarkably low for the risky country for any level of risk aversion (always below

0.5%). With higher degree of risk aversion, the increase in aggregate welfare gains masks an important heterogeneity across countries. Welfare gains are very unevenly shared between the safe and the risky country: the higher the degree of risk aversion, the more the safe country benefits from financial integration compared to the risky country. In the extreme case of $\gamma = 50$, welfare gains in the safe country account to 0.97% of permanent consumption (versus 0.42% in the baseline with $\gamma = 4$). The risky country has actually lower gains when $\gamma = 50$ (only 0.33% of permanent consumption) compared to our baseline with $\gamma = 4$ (0.53%). The intuition for this result goes as follows. The safe country has the technology that both countries prefer, i.e. a less risky production function. Comparative advantage logic would predict that the safe country benefits more from trading. The higher the risk aversion the more agents will value the safest technology, increasing thereby the wealth of the safe country. From the perspective of the risky country, it benefits more from risk sharing if more risk averse but the costs of reallocating risk are also much higher: insurance is more expensive in this case and the world interest rates is much lower upon integration (see Figure 4).

We also investigate how the welfare gains from financial integration for a high degree of risk aversion ($\gamma = 50$) interacts with standard neoclassical gains coming from capital scarcity. Figure 6 shows the welfare benefits (in % of permanent consumption) for both countries in our baseline ($\gamma = 4$) and for high risk aversion ($\gamma = 50$) as a function of the relative initial capital stocks ($\frac{k_{f,0}}{k_{h,0}}$).

In our baseline with CRRA utility, the curves exhibit a clear U-shape since large ex-ante differences in capital stocks increases benefits from efficient capital reallocation. The riskier country benefits however more from integration when capital scarce than when capital abundant. For most values of relative capital stock, the safer country benefits more from integration but the difference is small quantitatively for a low risk aversion. In our alternative with a high degree of risk aversion, as explained above, the safer country extracts a much larger share of the benefits. The risky country benefits less from integration when risk aversion is high, even if capital scarce since the dominant force driving the capital allocation across countries is the reallocation of precautionary savings. This makes it much less likely that

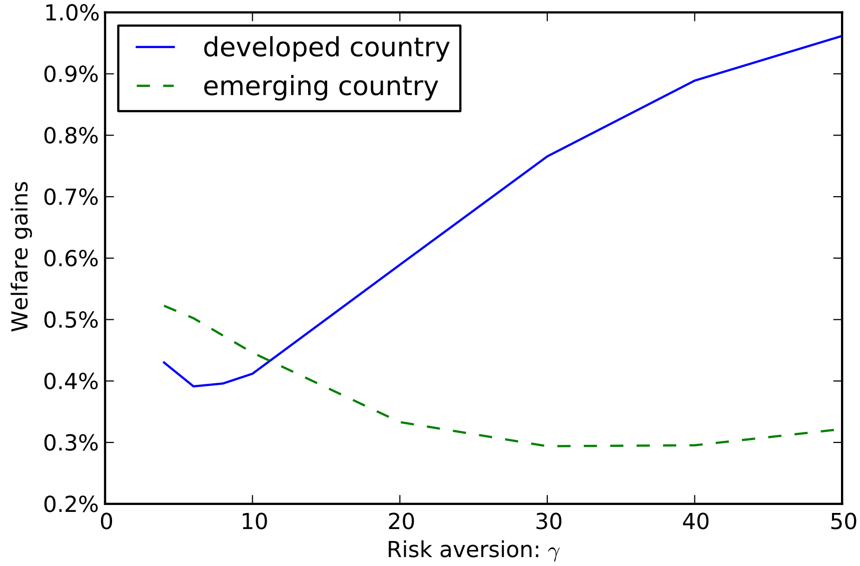

Figure 5: Welfare analysis of financial integration with higher degree of risk aversion (Epstein-Zin preferences).

Notes: Gains are expressed in % equivalent of permanent consumption as a function of the degree of risk aversion γ. Individuals have Epstein-Zin preferences with an elasticity of intertemporal substitution $1/\psi = 0.25$ and a risk aversion parameter $\gamma \geq 4$. $\gamma = 4$ corresponds to the CRRA case (Baseline low risk aversion). Other parameters of the model are kept identical to the ones shown in Tables 1 and 2.

financial opening will increase the stock of capital of the riskier country, thus despite a lower level of capital ex-ante. For the safer country, welfare gains are larger but the shape of the curve is also modified. The minimum is shifted to the left and the slope is now much steeper: when increasing ex-ante capital scarcity of the safe country, the additional gains from integration are larger. Contrary to the risky country, the reallocation of precautionary savings and the reallocation of capital due to capital scarcity of the safe country are complementing each other. With a high degree of risk aversion, the larger reallocation of precautionary savings away from the risky country accelerates the convergence of the safe country when capital scarce, boosting its gains from financial integration.

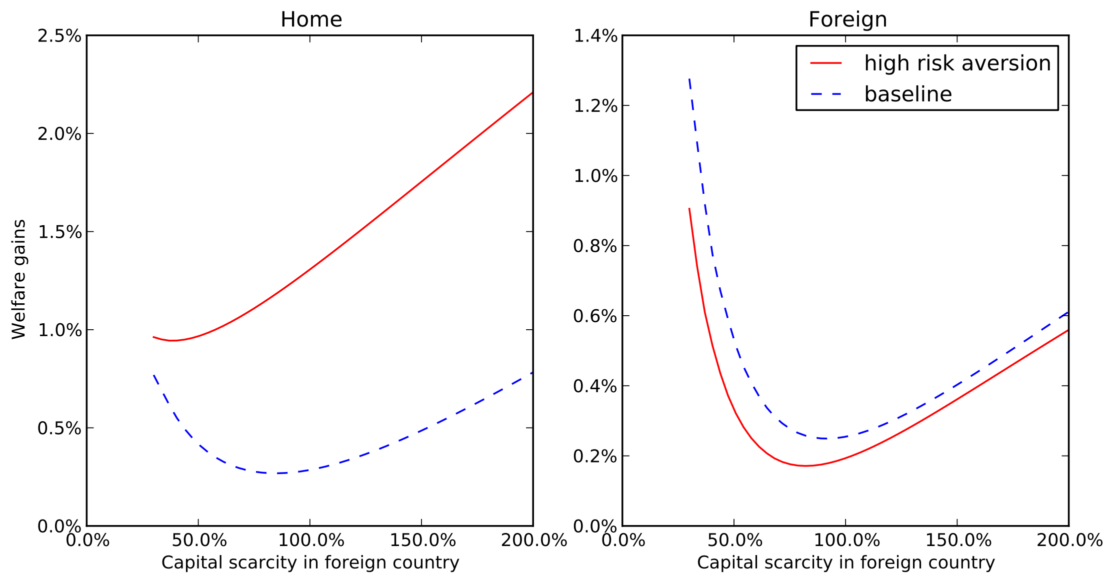

Figure 6: Welfare analysis of financial integration. Robustness with higher degree of risk aversion and different degrees of capital scarcity.
Notes: Gains are expressed in % equivalent of permanent consumption as a function of initial relative capital stock ($\frac{k_{f,0}}{k_{h,0}}$). The dotted lines correspond to our baseline calibration with CRRA utility ($\gamma = \psi = 4$). The solid lines corresponds to Epstein-Zin preferences with high risk aversion ($\gamma = 50$ and $\psi = 4$). Other parameters of the model are kept identical to the ones shown in Tables 1 and 2.

5 Robustness checks

We perform a wide range of robustness checks regarding the financial asset market structure (assuming complete markets), the stochastic process governing the shocks and the size of countries. Our main finding still holds: financial integration does not bring sizable welfare gains, in particular for riskier (emerging) economies where benefits do not exceed 1% of permanent consumption for realistic parameters values. Only a small, capital scarce and very safe country can extract significant welfare gains when integrating to riskier countries, a not so relevant case.

5.1 The role of financial markets structure

In our baseline incomplete markets model, international risk-sharing is limited due to the absence of state-contingent claims. Consumption volatility is thus only partially reduced. We go to the extreme case of complete financial markets (perfect international risk-sharing) as a robustness check. This provides a useful upper-bound of the gains from financial integration in our framework.

To solve the model under complete markets, we assume that the world economy consists in only one fictitious agent whose preferences are identical to those of each country (either CRRA with a coefficient γ in our baseline or Epstein-Zin preferences with coefficients ψ and γ. This agent invests optimally in both countries, maximizing its intertemporal utility subject to the resource constraints (Equation (11)) and the law of capital accumulation (Equation (2)).

Let us denote c_t^{CM} her consumption. With complete markets and symmetric preferences, each country i is consuming a constant fraction λ_i of the world consumption at all dates, with $\lambda_h + \lambda_f = 1$:

$$c_{i,t}^{CM} = \lambda_i c_t^{CM}$$

These fractions are allocated according to initial wealth at time of integration, which depends on initial state variables, the capital stock and the productivity level. Let us introduce the wealth of country i, defined as a claim on capital incomes net of investment and labor incomes (e.g. total production net of investment). After financial integration, both countries have the same stochastic discount factor m_{t+1} (defined in Equation (6), which is also the stochastic discount factor of the fictitious representative agent. The wealth in country i satisfies the following recursive equation:

$$W_{i,t} = (y_{i,t} - i_{i,t}) + E_t\{m_{t+1} W_{i,t+1}\}$$

At date of integration ($t = 0$), the initial consumption share λ_i in country i satisfies:

$$\lambda_i = \frac{W_{i,0}}{W_{1,0} + W_{2,0}}$$

Following our notations, we denote by $\overline{c}^{CM}$ the welfare of the representative (fictitious) agent in terms of permanent consumption equivalent. The homogeneity of preferences implies:

$$\overline{c_i}^{CM} = \lambda_i \overline{c}^{CM}$$

where $\overline{c_i}^{CM}$ denotes the welfare in terms of permanent consumption equivalent in country i after integration under complete markets. The welfare increase from financial integration under complete markets (in % of permanent consumption) follows immediately by computing $\frac{\overline{c_i}^{CM} - \overline{c_i}^{A}}{\overline{c_i}^{A}}$ for country i.

Figure 7 shows the welfare benefits from financial integration under complete the markets (solid line) a function of the relative initial capital stocks ($\frac{k_{f,0}}{k_{h,0}}$) in our baseline calibration (top panel) and with Epstein-Zin preferences and a high degree of risk aversion ($\gamma = 50$, bottom panel). The welfare gains are compared to our baseline model with incomplete markets (dotted line).

In the baseline calibration, welfare gains under complete markets are significantly higher than under incomplete markets, roughly doubling in magnitude. They do remain small, about 1% of permanent consumption. With a higher market price of risk (bottom panel of Figure 7), the welfare benefits of completing the markets are significantly higher. Depending on the level of initial capital stock and depending on the country, the gains are roughly two to four times larger than in the model with incomplete markets. In this case, completing the markets has a significant welfare impact since agents are extremely risk averse to consumption fluctuations. When countries start off with similar initial capital stock, they amount to about 3.5% of permanent consumption in the safe country and 2.5% in the risky one. This is arguably a loose upper bound of the welfare gains that can be achieved since risk aversion is unrealistically high and financial markets are complete under integration. The magnitude of the gains has changed but regarding the shape of the curves and the distribution of the gains across countries, all our results go through qualitatively. In particular, the gains are still unevenly distributed across countries when risk aversion is high, but less so compared to the incomplete markets model. With incomplete markets, the safe asset issued by country h

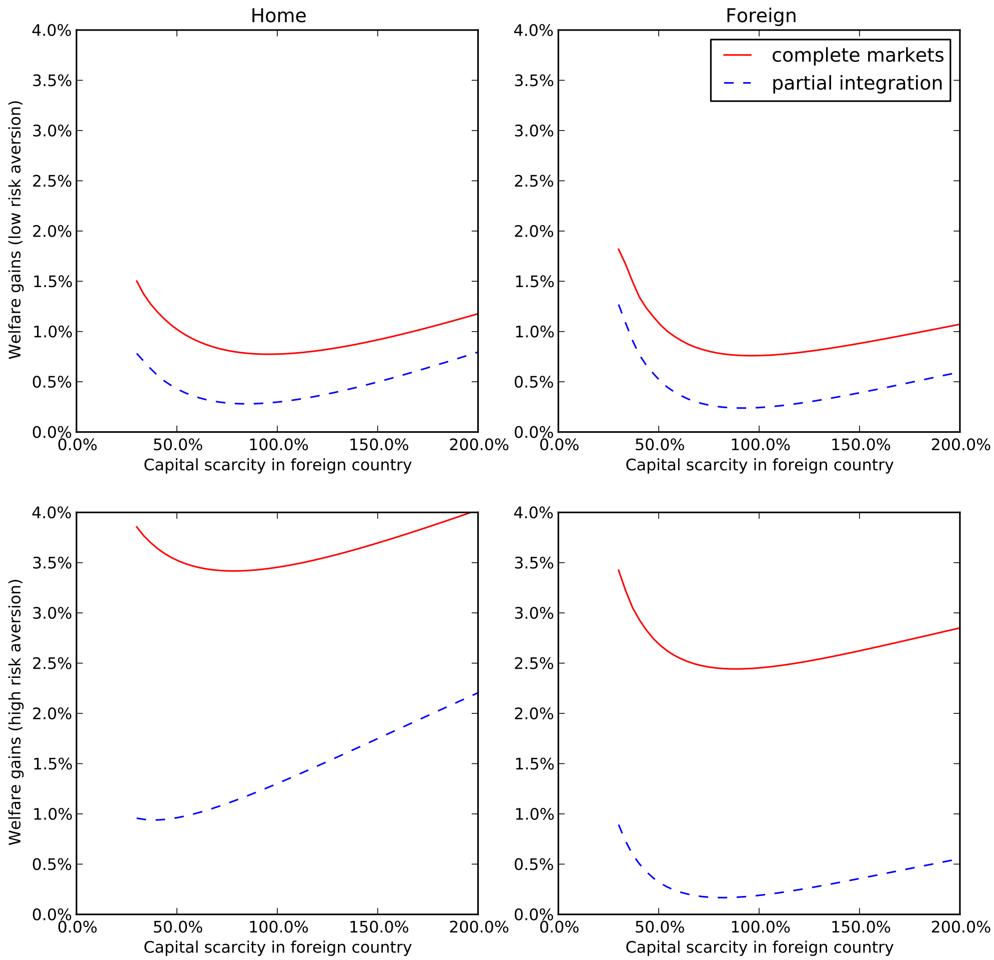

Figure 7: Welfare analysis of financial integration. Robustness with alternative financial markets structure.

Notes: Gains are expressed in % equivalent of permanent consumption as a function of initial relative capital stock $(\frac{k_{f,0}}{k_{h,0}})$. The solid line shows the welfare gains under complete financial markets. The dotted line corresponds to our baseline case with incomplete markets (bond-only). The upper panel corresponds to our baseline calibration with CRRA utility ($\gamma = \psi = 4$). The lower panel corresponds to Epstein-Zin utility with high risk aversion ($\psi = 4$ and $\gamma = 50$). Other parameters of the model are kept identical to the ones shown in Tables 1 and 2.

is more valuable since the country f is less able to smooth consumption.

5.2 Alternative specification of risks

Alternative stochastic structure. We investigate the robustness of our findings with respect to the stochastic structure in the baseline model of Section 2. We compute the welfare gains for different levels of volatility in the risky country σ_f and different correlation ζ of productivity shocks across countries (assumed to be zero in the baseline). For comparison, in our sample of emerging countries integrating to the world economy, the volatility of output ranges from 2.1% (Spain) to 8.7% (Jordan) (see Appendix B for details). The correlation of output growth between emerging countries and the sample of developed countries (already integrated) varies across regions, ranging from close to zero in Asia and Middle-East to 0.6 for Southern Europe countries.[21] The average (GDP-weighted) correlation across all liberalizing emerging markets is equal to 0.2 (see Appendix B for details on the correlation structure of GDP growth across countries). This suggests that potential gains from financial integration are slightly overestimated in our baseline calibration. In the following simulations, all parameters but the volatility σ_f and correlation ζ are kept to their baseline values (see Tables 1 and 2) and countries start from their respective autarky steady state (Experiment 2). Welfare gains from integration with alternative stochastic shocks are displayed in Table 5.

	$\zeta = 0$		$\zeta = 0.25$		$\zeta = 0.5$	
	h	f	h	f	h	f
(Symmetric risk) $\sigma_f = 2.5\%$	0.10	0.10	0.08	0.08	0.06	0.06
(Baseline) $\sigma_f = 5\%$	0.29	0.26	0.17	0.15	0.08	0.07
$\sigma_f = 7.5\%$	0.67	0.55	0.37	0.31	0.12	0.11
$\sigma_f = 10\%$	1.30	1.01	0.69	0.57		

Table 5: Welfare gains from financial integration with alternative stochastic structures

Notes: Welfare gains from financial integration are expressed in % equivalent of permanent consumption. Apart from σ_f and ζ, parameters of the model are set to their baseline values in Tables 1 and 2. Initial capital stock in both countries is equal to its autarky steady-state value.

Higher correlation of shocks ζ reduces the gains from integration, limiting the ability of countries to share risks internationally. Note that gains fall fairly quickly with the level of correlation and are almost negligible with $\zeta = 0.5$. If one considers a correlation ζ of 0.25

[21] Abstracting from Southern Europe, the correlation of output growth a given region of emerging markets with developed countries is always between 0 and 0.35.

and a volatility σ_f of 5%, very close to the empirical average across liberalizing emerging markets (see Appendix B), gains from financial integration amounts to roughly 0.15% in both countries. Larger asymmetry in aggregate risk across countries increases the welfare gains for both countries but the safe country benefits more. As country f gets riskier, its precautionary demand for safe assets at opening increases, which benefits more to the safe country.

5.3 The role of countries size

Welfare gains with small countries. So far our experiments rely on countries of equal sizes, focusing on the integration of a set of potentially large emerging countries. We consider it as a reasonable baseline to understand the recent liberalizing wave where large emerging markets, accounting for almost 50% of world GDP did integrate financially at similar dates. However, one could argue that some emerging countries did integrate at earlier (resp. later) dates and were a much smaller share of world GDP such as Southern Europe countries (resp. some Middle East countries).[22] From a theoretical perspective, investigating the importance of countries size in assessing the welfare benefits of integration provides an upper bound of the potential gains and allows comparisons with papers focusing on the case of small open economies (e.g. Gourinchas and Jeanne (2006), Obstfeld (1994b)).

Indeed, our baseline calibration might understate the welfare gains from financial integration of smaller open economy. Smaller countries have less impact on the world interest rate and are thus less negatively affected by adverse movements in the world interest rate, both at opening and when hit by a productivity shock. To investigate the importance of size, we explore the case of different initial (steady-state) relative productivity across-countries $\left(\frac{A_{f,0}}{A_{h,0}}\right)$.[23] We assume that country f is of a smaller size being on average ten times less productive: $\frac{A_{f,0}}{A_{h,0}} = \frac{1}{10}$. All other parameters values are kept identical to our baseline experiment (Tables 1 and 2). Welfare gains from integration (% of permanent consumption) are shown in Figure

[22] Spain, Portugal and Greece integrated financially in the mid-eighties slightly before the main wave of liberalization in Latin America and Asia in the early nineties. Countries such as Oman and Saudi Arabia integrated financially in the late nineties (1999).

[23] Note that this is perfectly homogenous to a lower population in country f. Essentially, our productivity ratio pins down the relative size of countries.

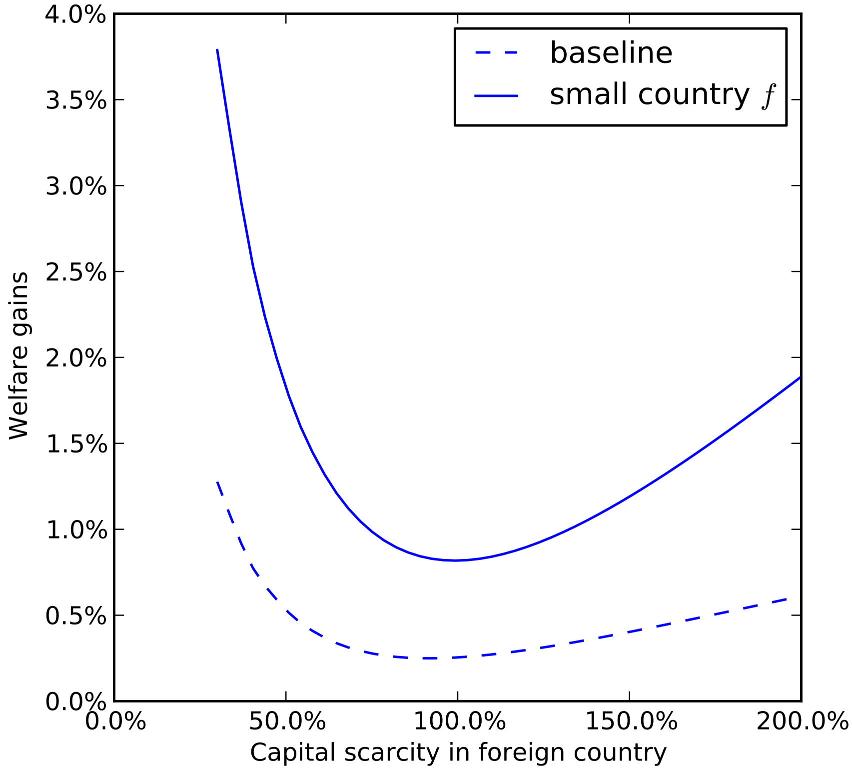

Figure 8: Welfare analysis of financial integration. Robustness with countries of different sizes.
Notes: Welfare gains are expressed in % equivalent of permanent consumption as a function of initial relative capital stock $(\frac{k_{f,0}}{k_{h,0}})$. Parameters of the model are shown in Tables 1 and 2 apart from from relative productivity $\frac{A_{f,0}}{A_{h,0}}$. Financial integration is a bond-only economy. The solid line shows the welfare gains with a country f five times smaller than h: $A_{f,0}/A_{h,0}$= 10%. The dotted line corresponds to our baseline case of symmetric initial productivity.

8 for the risky country of small size for different values of the relative initial capital stocks $(\frac{k_{f,0}}{k_{h,0}})$. The results in the baseline case of symmetric initial size/productivity (dotted line) are shown for comparison purposes.[24]

Not surprisingly, market size matters for the distribution of the gains and country f benefits more from financial integration if smaller. The converse holds for the large country h. Interest rates move more favorably for country f following financial integration: f is now lending at higher rates, very close to the autarky interest rate of country h. Similarly, when country f is willing to lend more following a productivity shock, interest rates do not fall as much and

[24]The large safe country is not shown as for such a large size difference in size, welfare gains are negligible in country h.

the country can smooth consumption at a better price. The overall welfare gains (average across countries weighted by size) remain small. And even in this case where gains fall almost entirely on country f, they do not exceed a 1.5% increase of permanent consumption for realistic degree sof capital scarcity. They are of the same order of magnitude than in the riskless case despite additional gains from risk sharing: as in the baseline experiment with equal sizes, the reallocation of precautionary savings away from f dampens significantly the potential gains from capital scarcity.[25]

Quantitative experiments with smaller countries. We now provide alternative experiments calibrated to the experience of some countries in South Europe (Greece, Portugal and Spain) and Middle-East (Oman and Saudi Arabia) which did not integrate financially during the large wave of financial liberalization of the early nineties. Greece, Portugal and Spain integrated earlier (around 1986) while Oman and Saudi Arabia integrated later in 1999. It is reasonable to argue that at their respective integration date, they were of small sizes compared to the set of developed countries.

	Liberalization (average)	Volatility σ_f	Correlation ζ	Capital scarcity $k_{f,0}/h_{h,0}$
'Early' South Europe	1986	2.7%	0.6	85%
'Late' Middle-East	1999	8.1%	-0.01	35%

Table 6: Characteristics at time of integration of 'Early' South Europe (Greece-Portugal-Spain) and 'Late' Middle-East (Saudi Arabia and Oman)

Notes: Penn World Tables and Bekaert et al. (2005) for the liberalization dates. Volatility, correlation and degree of capital scarcity are GDP-weighted averages of the countries in the group. [**capital scarcity might be revised slightly**]. The correlation of annual real output growth per capita for each country is computed over the period 1975-2010, the volatility over the period 1975-1995. GDP weights are based on PPP GDP in 1990. See Appendix **??** for further details.

Data for these countries at integration date are shown in Table 6. 'Early' South European countries are significantly less risky than their emerging markets counterpart (average volatility of 2.7%) but significantly more capital abundant and more correlated in terms of

[25] With such a size for f, results in the deterministic case are quantitatively very close to the small open economy experiment performed in Gourinchas and Jeanne (2006).

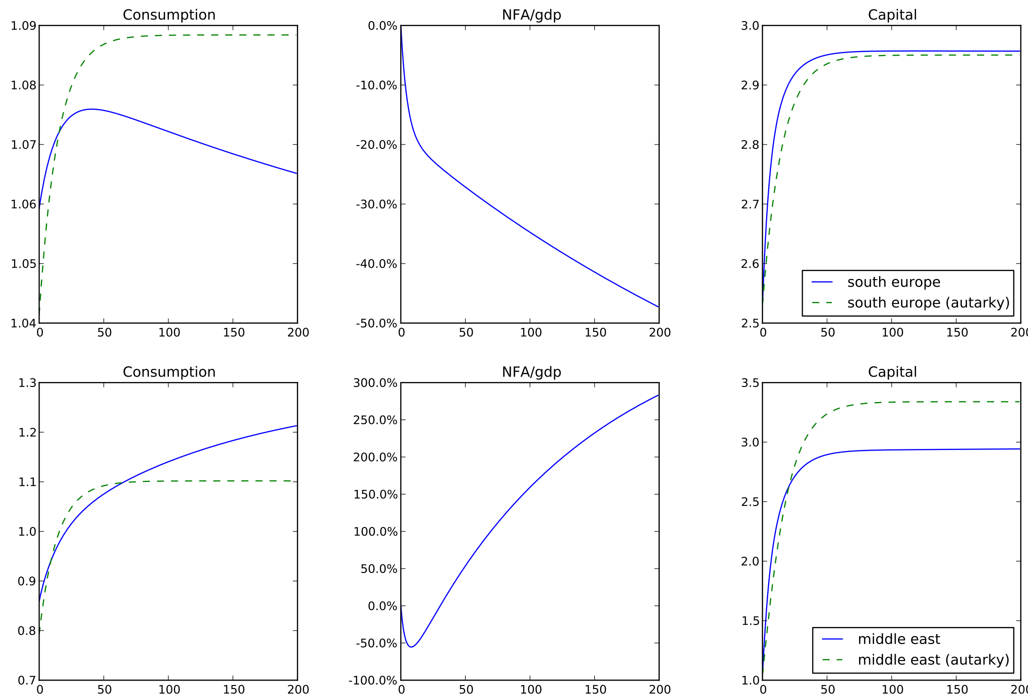

Figure 9: Dynamics along the risky path following integration the case of Early South Europe (Greece-Portugal-Spain, top panel) and Late Middle-East (Oman-Saudi Arabia, bottom panel)

Notes: Parameters regarding country f (Early South Europe or Late Middle-east) are shown in Table 6. Other structural parameters of the model are shown in Table 1 and 2.

output growth with the rest of the world. 'Late' Middle-East countries are to the opposite significantly more volatile (volatility of 8.1%), have zero correlation of output growth with the rest of the world and are significantly capital scarce. We calibrate our experiment for these countries using the corresponding data of Table 6. Structural parameters are set to their baseline values of Table 1 and 2.[26]

Figure 9 shows the dynamics of these economies in our calibrated experiment. Southern Europe starts to grow faster at opening due to its initial capital scarcity combined with low level of aggregate risk, attracting capital inflows. Despite being significantly more capital scarce, Middle-East countries grow at a very similar pace at opening and even at a slower pace compared to autarky later on. They also cut their consumption in the short-run compared to

[26]Note that the volatility of developed countries (already integrated) is kept to 2.5% despite a large group of more volatile emerging markets being integrated in 1999 when 'Late' Middle-East countries joined.

autarky. While capital scarcity induces them to run very small current account deficit initially, they move quickly into surplus and accumulate large positive net foreign asset positions as they reallocate their precautionary savings towards safer countries. These two experiments illustrates well the heterogeneous responses of countries to financial integration. Welfare gains (in % increase in permanent consumption) amount to 0.08% in the case of Greece-Portugal-Spain (GPS) and 1.10% for Oman-Saudi Arabia. They remain fairly low in both cases but for different reasons: for South Europe (GPS), gains are low due to low expected gains from risk-sharing and low degree of capital scarcity as in Gourinchas and Jeanne (2006); for Middle-East countries, gains are low due high aggregate volatility of these countries such that the reallocation of precautionary savings reduces gains from capital scarcity.

6 Conclusion

Intuitions about the gains from financial integration are implicitly based on neoclassical growth model. We fill an important gap in the theoretical literature that has either focused on deterministic efficiency gains in production economies or gains from international risk sharing, but neglecting the adjustment of production factors across countries. We provide an integrated framework where one can study the standard neoclassical efficiency gains together with gains from risk sharing and investigate how they interact. Using a general equilibrium model featuring aggregate risk, potentially asymmetric across countries, and endogenous capital accumulation, we show that the welfare gains from financial integration are small, at most a few percentage points even in the most favourable cases where risk premia are high and international risk sharing is perfect (complete financial markets). This is so despite the possibility of having neoclassical efficiency gains arising from capital scarcity and gains from international risk sharing.

A key feature of our finding is that riskier countries while benefiting more from risk sharing will also reallocate precautionary savings towards the safer countries, boosting its capital accumulation. This has two important implications. First, it qualifies the conventional wisdom that riskier countries should have large gains from financial integration. In reality, safer (developed) country are benefiting more from their integration with riskier (emerging) countries. This is so because they sell insurance at a high price, even more so if risk aversion and risk premia are high. Second, it also qualifies the standard predictions linking financial integration and growth. In our framework, the predictions are much more complex and financial integration has heterogeneous effects on growth depending on the degree of capital scarcity, the level of risk and the size of countries. Financial integration potentially reduces growth in emerging markets compared to autarky if their level of aggregate risk is high compared to developed countries (or if market price of risk is high), thus despite being welfare enhancing. If emerging markets are sufficiently capital scarce at opening, financial integration accelerates growth in the short-run but slows it down at longer horizons. This potential heterogeneous output responses across countries and across time following financial integration can partially explain why the empirical literature has had difficulties to find robust results across countries and time-periods. Our results also open the door for a new empirical investigation regarding the growth effect of financial integration.

Finally, we focused on previous liberalization episodes where a group of large emerging countries integrated over a short time period. We emphasized how general equilibrium effects were detrimental in that case, reducing significantly the gains compared to the case where only one small country is integrating. This is also potentially challenges the way the growth benefits of integration have been identified empirically as the literature implicitly assumes that the growth impact of integration is independent across countries. Moreover, from a theoretical perspective, this has the flavour of a pecuniary externality. Individually, benefits of integration can outweigh significantly the costs but correlated behaviour where all emerging countries simultaneously integrate reduces significantly the gains due to adverse price movements. A full-fledged theory of endogenous financial integration with multiple countries is beyond the scope of the paper and left for future work.

References

[1] Acemoglu, D. and Zilibotti, F., 1997. Was Prometheus unbound by chance? Risk, diversification and growth. Journal of Political Economy 105, 709-751.

[2] Aguiar, M. and Gopinath, G., 2007. Emerging Market Business Cycles: The Cycle Is the Trend. Journal of Political Economy, vol. 115, p 69-102.

[3] Aiyagari, S. R., 1994. Uninsured Idiosyncratic Risk and Aggregate Saving. Quarterly Journal of Economics 109, 659-684

[4] Angeletos, M. and Panousi V, 2011. Financial Integration, Entrepreneurial Risk and Global Dynamics. Journal of Economic Theory 146:3.

[5] Arteta, C.O., Eichengreen, B., Wyplosz, C., 2003. On the growth effects of capital account liberalization. In: Helpman, E., Sadka, E. (Eds.), Economic Policy in the International Economy: Essays in Honor of Assaf Razin. Cambridge University Press, Cambridge.

[6] Athanasoulis, S. and Van Wincoop, E. 2000. Growth Uncertainty and Risk-Sharing. Journal of Monetary Economics, 45, 477–505.

[7] Athanasoulis, S. and R.J., Shiller, 2001. World Income Components: Measuring and Exploiting Risk-Sharing Opportunities. American Economic Review, vol. 91(4), p 1031-1054.

[8] Backus, David K.; Kehoe, Patrick J.; Kydland, Finn E, 1992. International Real Business Cycles. Journal of Political Economy 100: 745-775

[9] Baxter, M. and Jermann, U., 1997. The International Diversification Puzzle Is Worse Than You Think. American Economic Review, vol. 87(1), pages 170-80, March.

[10] Bekaert, G., Harvey, C. and Lundblad, C. 2005. Does Financial Liberalization Spur Growth?. Journal of Financial Economics, 77 (1), 3–55.

[11] Bekaert, G., Harvey, C. and Lundblad, C., 2006. Growth Volatility and Financial Liberalization. Journal of International Money and Finance, 25(3), 70-403.

[12] Boyd, J. H. and Smith, B. D. 1997. Capital Market Imperfections, International Credit Markets, and Nonconvergence. Journal of Economic Theory, 73 (2), 335–364.

[13] Campbell, J., 2003. Consumption-Based Asset Pricing. in: G.M. Constantinides, M. Harris, R. M. Stulz (ed.), Handbook of the Economics of Finance, Elsevier. 1 (13), 803-887.

[14] Chari, A., Henry, P.B., 2004. Risk sharing and asset prices: evidence from a natural experiment. Journal of Finance 59, 1295–1324.

[15] Clarida, R., 1987. Consumption, liquidity constraints and asset accumu- lation in the presence of random income uctuations. International Economic Review, 28(2), 339-351.

[16] Coeurdacier, N. and Guibaud, S., 2009. A Dynamic Equilibrium of Imperfectly Integrated Financial Markets. manuscript, London Business School

[17] Coeurdacier, N., Rey, H., and Winant, P., 2011. The Risky Steady State. American Economic Review Papers and Proceedings, 101(3), 398-401.

[18] Coeurdacier, N. and H. Rey. 2013. Home Bias under Open Economy Financial Macroeconomics. Journal of Economic Literature, 51(1), 63-115.

[19] Colacito, R., and M.M. Croce, 2010. The Short and Long Run Bene ts of Financial Integation. American Economic Review, 100(2), 527-531.

[20] Cole H. and Obstfeld, M., 1991. Commodity trade and international risksharing: how much do financial markets matter?. Journal of Monetary Economics, 28 (1991), pp. 3–24.

[21] Corneli, F., 2010. Medium and Long Run Implications of Financial Integration without Financial Development. Bank of Italy mimeo.

[22] Devereux, M.B., Smith, G.W., 1994. International risk sharing and economic growth. International Economic Review 35, 535–551.

[23] Edison, H., Levine, R., Ricci, L. and Skloek, T. 2002. International Financial Integration and Economic Growth. Journal of International Money and Finance, 21, 749–776.

[24] Eichengreen, B., 2002. Capital account liberalization: what do the cross-country studies tell us? World Bank Economic Review 15, 341–366.

[25] Epstein, L.G. and Zin, S.E., 1989. Substitution, Risk Aversion, and the Temporal Behavior of Consumption and Asset Returns: A Theoretical Framework. Econometrica, Vol. 57, No. 4, pp. 937-969

[26] Fisher, J., 2006. The Dynamic Effects of Neutral and Investment-Specific Technology Shocks.Journal of Political Economy 114, 413-52

[27] French, K. and J. Poterba, 1991, Investor Diversification and International Equity Markets, American Economic Review, 81, 222-26.

[28] Gourinchas, P.-O. and Jeanne, O. 2006. The Elusive Gains from International Financial Integration. Review of Economic Studies, 73, 715–741

[29] Gourinchas, P.-O. and Jeanne, O., 2008. Capital flows to developing countries: the allocation puzzle. NBER Working Paper No. 13602.

[30] Greenwood, J., Z. Hercowitz and P. Krusell, 1997. Long-Run Implications of Investment-Specific Technological Change. American Economic Review, American Economic Association87, 342-62.

[31] Greenwood, J., Z. Hercowitz and P. Krusell, 2000. The Role of Investment-Specific Technological Change in the Business Cycle. European Economic Review 44, 91-115.

[32] Guvenen, F., 2006. Reconciling Conflicting Evidence on the Elasticity of Intertemporal Substitution: A Macroeconomic Perspective. Journal of Monetary Economics, 53, 1451-1472.

[33] Hall, R., 1988. Intertemporal Substitution in Consumption. Journal of Political Economy, 96, 339-357.

[34] Hall, R.E and Jones, C., 1999. Why Do Some Countries Produce So Much More Output Per Worker Than Others? Quarterly Journal of Economics, 114(1), 83-116.

[35] Henry, P.B., 2000. Stock market liberalization, economic reform, and emerging market equity prices. Journal of Finance 55, 529–564.

[36] Henry, P.B., 2000. Do Stock Market Liberalizations Cause Investment Booms? Journal of Financial Economics, 58, 301-34.

[37] Henry, P. B., 2003. Capital Account Liberalization, the Cost of Capital, and Economic Growth. American Economic Review (Papers and Proceedings), 93 (2), 91–96.

[38] Jeanne, O., Subramanian, A. and Williamson, J., 2012. Who Needs to Open the Capital Account? Peterson Institute.

[39] Juillard, M., 2012. Local approximation of DSGE models around the risky steady-state. Mimeo Bank of France.

[40] Jermann, U., 1998. Asset pricing in production economies. Journal of Monetary Economics, 41(2), 257-275.

[41] Judd, K. L. K., Kubler, F.and Schmedders, K., 2002. A solution method for incomplete asset markets with heterogeneous agents. Unpublished manuscript.

[42] Kaminsky, G.L., Schmukler, S.L., 2002. Short-run pain, long-run gain: the effects of financial liberalization. Unpublished working paper, George Washington University, Washington, DC.

[43] Kose M. A., Prasad E., Rogoff K., Wei S. J., 2009. Financial Globalization: A Reappraisal. IMF Staff Papers, 56, 8–62.

[44] Kose M. A., Prasad E. and Terrones, M. 2007. How Does Financial Globalization Affect Risk Sharing? Patterns and Channels. IMF Working Papers 07/238, International Monetary Fund.

[45] Kraay, A. Loayza, N., Serven, L. and J. Ventura, 2005. Country Portfolios. Journal of the European Economic Association, 3(4), 914-945.

[46] Krueger, D., and Kubler, F. 2004. Computing equilibrium in OLG models with stochastic production. Journal of Economic Dynamics and Control, 28 (7), 1411-1436.

[47] Kubler, F. and Schmedders, K, 2003. Stationary Equilibria in Asset-Pricing Models with Incomplete Markets and Collateral. Econometrica. 71(6): 1767-1793.

[48] Lane, P. and G.M. Milesi-Feretti, 2003, International Financial Integration, IMF Staff Papers, 50., 82-113.

[49] Lewis, K., 1996. What can explain the apparant lack of international consumption risksharing?. Journal of Political Economy, 104 (2), 267–297.

[50] Lewis, K., 1999. Trying to explain home bias in equities and consumption. Journal of Economic Literature, 37, 571-608.

[51] Lewis, K., and E.X. Liu, 2012. International Consumption Risk Is Shared After All: An Asset Return View. NBER Working Paper No. 17872.

[52] Lewis, K., 2000, Why do stocks and consumption imply such different gains from international risk sharing?, Journal of International Economics 52, 1-35.

[53] Lucas, R., 1990. Why Doesn't Capital Flow from Rich to Poor Countries?. American Economic Review 80(2), 92-96.

[54] Lucas, R., 1987. Models of Business Cycles. Oxford: Basil Blackwell.

[55] Matsuyama, 2004. Financial Market Globalization, Symmetry-Breaking, and Endogenous Inequality of Nations. Econometrica, 72 (3), 853–884.

[56] Martin, I., 2010. How Much Do Financial Markets Matter? Cole-Obstfeld Revisited. mimeo Stanford GSB.

[57] Milesi-Ferretti, G.M. and Cedric T., 2010. The Great Retrenchment: International Capital Flows during the Global Financial Crisis. Economic Policy, vol. 66, pp. 285-330.

[58] Mendoza, E., Quadrini, V. and Rios-Rull, V., 2008. Financial Integration, Financial Deepness and Global Imbalances. Journal of Political Economy 115, 665-703.

[59] Mendoza, E., Quadrini, V. and Rios-Rull, V., 2007. On the welfare implications of Financial globalization without Financial development. NBER International Seminar on Macroeconomics (ISOM)

[60] Obstfeld, M., 1994a. Risk-Taking, Global Diversification and Growth. American Economic Review, 85, 1310–1329.

[61] Obstfeld, M., 1994b. Evaluating Risky Consumption Paths: The Role of Intertemporal Substitutability. European Economic Review

[62] Obstfeld, M., 2009. International Finance and growth in developing countries: what have we learned?, IMF staff papers vol 56, n1.

[63] Obstfeld, M., 2012. Financial Flows, Financial Crises, and Global Imbalances. Journal of International Money and Finance, 31, p 469–480.

[64] Ogaki M. and C.M. Reinhart, 1998. Measuring Intertemporal Substitution: The Role of Durable Goods. The Journal of Political Economy, vol. 106(5), 1078-1098.

[65] Ostry, J.D. Ghosh, A., Habermeier, K., Chamon, M., Qureshi, M. and Reinhardt, D., 2010. Capital Inflows: The Role of Controls. IMF Staff Position Note.

[66] Pallage, S. and Robe, M.A., 2003. On the Welfare Cost of Economic Fluctuations in Developing Countries. International Economic Review, vol. 44(2), pp 677-698.

[67] Prasad, E.S, , Rajan, R.G and Subramanian, A., 2007. Foreign capital and economic growth. Brookings Papers on Economic Activity 38, 153-230.

[68] Prasad, E.S, Rogoff, K., Wei, S. and Kose, M. A. 2003. Effects of Financial Globalization on Developing Countries: Some Empirical Evidence. IMF Occasional Paper No. 220.

[69] Quinn, D., Toyoda, A.M., 2008. Does capital account liberalization lead to economic growth? an empirical investigation. Review of Fiancial Studies, 21 (3), 1403-1449.

[70] Rendahl, P., 2006. Inequality constraints in recursive economies. Mimeo.

[71] Rodrik, D. 1998. Who Needs Capital Account Convertibility? in P. Kennon (ed.), Princeton Essays in International Finance, No. 207. Princeton, NJ: Princeton University.

[72] Rouwenhorst, K.G., 1995. Asset Pricing Implications of Equilibrium Business Cycle Models. In: Cooley, T.F. (Ed.), Frontiers of Business Cycle Research. Princeton University Press, Princeton, 294-330.

[73] Schmitt-Grohe, S. and M. Uribe, 2003. Closing small open economy models. Journal of International Economics, 61(1): 163-185.

[74] Tesar, L., 1995. Evaluating the gains from international risksharing. Carnegie-Rochester Conference Series on Public Policy, Elsevier, vol. 42(1), pages 95-143, June.

[75] Van Wincoop, E., 1999. How big are potential welfare gains from international risksharing?. Journal of International Economics, Elsevier, vol. 47(1), pages 109-135, February.

[76] Van Wincoop, E., 1994. Welfare gains from international risksharing. Journal of Monetary Economics, 34, 175–200.

[77] Vissing-Jørgensen, A., 2002. Limited asset market participation and the elasticity of intertemporal substitution. Journal of Political Economy, vol. 110(4), 825-853.

[78] Weil, P., 1990. Nonexpected Utility in Macroeconomics. Quarterly Journal of Economics, 105, 29-42.

[79] Yogo, M., 2004. Estimating the Elasticity of Intertemporal Substitution When Instruments Are Weak. The Review of Economics and Statistics, vol. 86(3), 797-810.

A Numerical methods

[to be written]

B Data

B.1 Data sources and countries sample

Data sources.

Capital account liberalization dates: Bekaert et al. (2005).

GDP, Investment, GDP per capita: Penn World Tables. Sample period varies across countries depending on data availability (1950-2009 for developed countries, later starting date for most emerging markets but not later than 1975).

Sample of countries. 15 always financially opened developed countries. 40 liberalizing emerging markets (integration date $\geq$ 1985). Emerging markets do not include countries from Central and Eastern Europe due to lack of data before 1990.

Developed countries (already financially integrated in 1985).

Australia, Austria, Canada, Denmark, Finland, France, Germany, Ireland, Japan, Italy, Netherlands, Sweden, Switzerland, United Kingdom, United States.

Emerging countries (by geographical zone, financial integration date in parenthesis from Bekaert et al. (2005)).

Southern Europe: Greece (1987), Israel (1993), Malta (1992), Portugal (1986), Spain (1985), Turkey (1989).

Latin America: Argentina (1989), Brazil (1991), Chile (1992), Colombia (1991), Ecuador(1994), Jamaica (1991), Mexico (1989), Peru (1992), Trinidad and Tobago (1997), Venezuela (1990).

Asia: Bangladesh (1991), China.(1991),[27] India (1992), Indonesia (1989), Malaysia (1988), Pakistan (1991), Philippines (1991), South Korea (1992), Sri Lanka (1991), Thailand (1987).

Middle-East: Egypt (1992), Jordan (1995), Oman (1999), Saudi Arabia (1999).

Africa: Botswana (1990), Ghana (1993), Ivory Coast (1995), Kenya (1995), Mauritius (1994), Morocco (1988), Nigeria (1995), Tunisia (1995), South Africa (1996), Tunisia (1995), Zimbabwe (1993).

Countries sizes.

Table B.1 shows the PPP adjusted share of world GDP of each group of countries in 1990. World GDP is made of our set of 55 countries (15 developed financially opened and 40 liberalizing emerging markets). For comparison purposes, the US accounts in 1990 for 21.3% of the world GDP we consider.

Zone	Developed	Southern Europe	Latin America	Asia	Middle East	Africa	All Emerging
Share of World GDP	51.4%	5.6%	12.9%	26.7%	1.6%	2.1%	48.6%

Table B.1: Contribution to world GDP of group of countries in 1990.
Notes: Data from Penn World Tables. PPP adjusted GDP in 1990. World is made of our sample of 55 countries (15 developed countries and 40 emerging liberalizing countries). See Section B.1 for the sample of countries.

B.2 Output growth volatility and correlation

Volatility of output growth. We compute the volatility of annual real GDP per capita for each country in the sample over the period 1975-1995 (PPP adjusted). This corresponds largely to the time period before and around the integration date of the emerging markets

[27] According to the definition of Bekaert et al. (2005), China remains closed over the period considered. According to other indicators of financial integration, the country can be considered as opened starting 1991 (see Bekaert et al. (2005) for a discussion). We do include China in our sample of liberalizing emerging markets.

considered. Volatility computed over a longer time frame gives very similar results. Figure B.1 reports the volatility for each group of countries (arithmetic or GDP-weighted average across countries belonging to the group) The (arithmetic) averaged volatility of output growth across liberalizing emerging countries is 4.9% compared to 2.5% in developed countries, in line with our baseline calibration.[28]

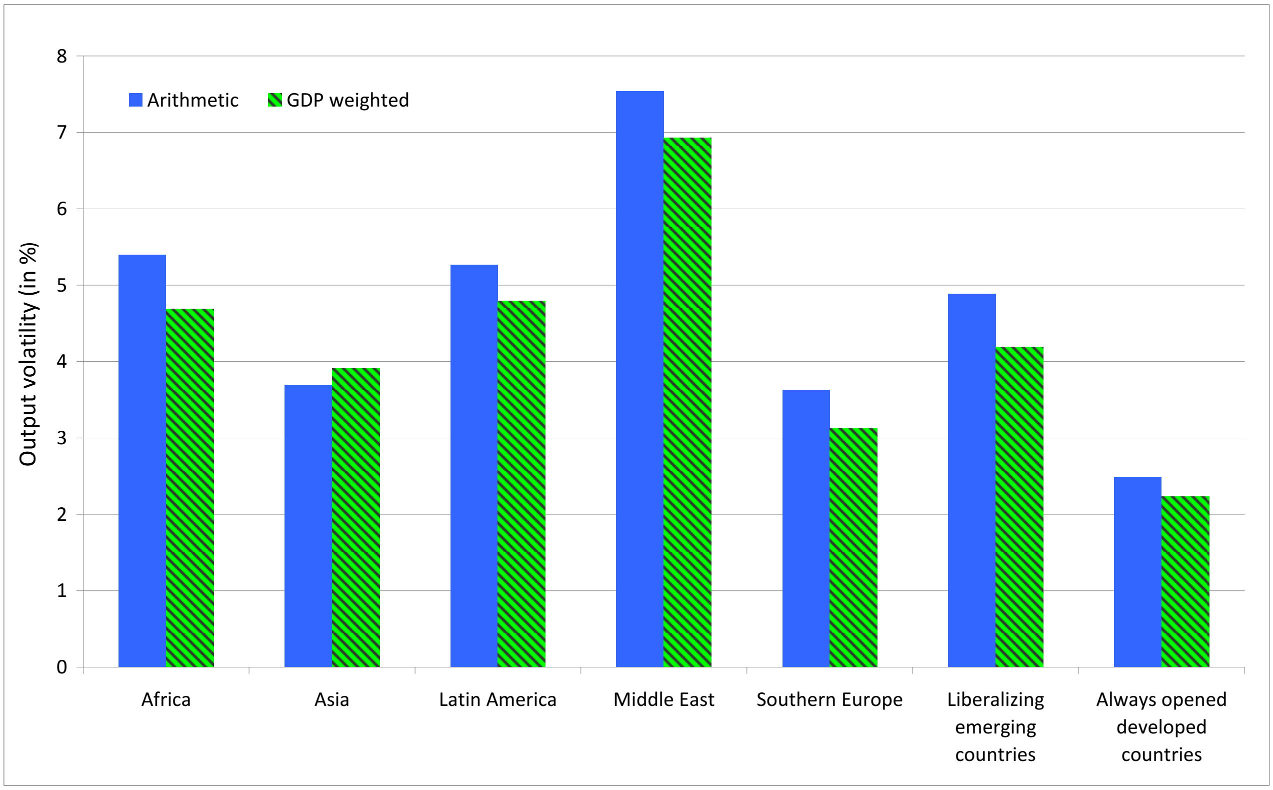

Figure B.1: Volatility of annual real output growth per capita across countries (1975-1995). Notes: Penn World Tables. Volatility of annual real output growth per capita for each country is computed over the period 1975-1995. Volatility of each group of countries is a sample average (arithmetic or GDP-weighted) of the volatility of each country in the group as defined in Section B.1. GDP weights are based on PPP GDP in 1990.

Correlation of output growth with developed countries. For any given country, we also compute the correlation of annual real GDP growth per capita in the country with the group of (already integrated) developed countries over the period 1975-2010[29]. We compute

[28]We display simple arithmetic averages and GDP-weighted (using 1990 PPP GDPs) averages. Both are very similar quantitatively although the GDP-weighted averages tend to be smaller (except for Asia) since larger countries tend to be less volatile. Importantly, the ratio of volatilities between developed and emerging markets is very similar across the two measures.

[29]We used a longer time frame to compute correlations for a better accuracy of our estimates but results

the arithmetic and the GDP-weighted means in a given group of countries (region or whole sample of liberalizing countries). Results are shown in Table B.2. Our baseline assume zero correlation while the correlation is between 0 and 0.25 for all groups but Southern Europe, which is significantly higher. Thus, If anything, we overestimate slightly the gains from financial integration in our baseline.

Zone	Southern Europe	Latin America	Asia	Middle East	Africa	All Emerging
Correlation with developed (Arithmetic mean)	0.53	0.14	0.10	0.00	0.27	0.21
Correlation with developed (GDP-weighted mean)	0.60	0.22	−0.01	0.06	0.35	0.14

Table B.2: Correlation of annual real output growth with the sample of (already integrated) developed countries (1975-2010).

Notes: Penn World Tables. The correlation of annual real output growth per capita for each country is computed over the period 1975-2010. Real per capita GDP growth of the sample of (already integrated) developed countries is a GDP-weighted average of the growth of countries in the sample. The correlation for each group of countries is a sample average (arithmetic or GDP-weighted) of the correlation of each country in the group as defined in Section B.1. GDP weights are based on PPP GDP in 1990.

B.3 Capital scarcity

Definitions. Consider a country i with the following production function at date t:

$$Y_{i,t} = A_{i,t}\,(K_{i,t})^{\theta}\,(L_{i,t})^{1-\theta}$$

where $K_{i,t}$ denotes the capital stock, $A_{i,t}$ the country TFP and $L_{i,t}$ the labour supply.

Capital-output ratio $(\frac{K}{Y})_{i,t}$ is then a monotonic transformation of capital per efficiency units $k_{i,t} = \frac{K_{i,t}}{A_{i,t}^{1/(1-\theta)} L_{i,t}}$:

$$(\frac{K}{Y})_{i,t} = (\frac{K_{i,t}}{A_{i,t}^{1/(1-\theta)} L_{i,t}})^{1-\theta} = k_{i,t}^{1-\theta}$$

are very similar when considering the period 1975-1995. The real GDP growth rate of developed country is weighted sum of the GDP growth rates of each country, where weights correspond to the size of countries.

Thus capital per efficiency units $k_{i,t}$ can easily be recovered from capital-output ratio as follows:

$$k_{i,t} = \left[(\frac{K}{Y})_{i,t} \right]^{1/1-\theta} \tag{1}$$

$k_{i,t}$ is the empirical counterpart of the capital stock in the model of Section 2.

Capital stocks. We compute the stock of capital $K_{i,t}$ of country i at date t using the perpetual inventory method with a depreciation rate of $\delta = 8\%$ per year (see Hall and Jones (1999)).

The initial value capital stock at date t_0 is defined as:

$$\frac{\text{Investment rate at } t_0}{\delta + g_{t_0}},$$

where g_{t_0} is the average geometric growth rate of investment over the ten years preceding t_0. The initial period t_0 considered depends on data availability for a given country. For developed countries, we use 1960, for emerging markets, we use generally 1970 and at the latest 1980. Results are quite insensitive to the use of a common initial date across countries if anterior to 1980.

We compute the capital-output ratio $(\frac{K}{Y})_{i,t}$ at date t in country i defined as $K_{i,t}$ divided by GDP of that year (all expressed in constant 2005 USD). $k_{i,t}$ is then defined according to Equation (1) with $\theta = 0.3$.

The capital-output ratio of the sample of developed countries (already integrated in 1985) is the GDP-weighted average of capital-output ratios in these countries. Their capital per efficiency unit of developed countries k_t^* is defined according to Equation (1) with $\theta = 0.3$.

Capital scarcity at date of financial opening. Consider an emerging country i integrating financially at date t_i with the sample of developed country $(*)$. We measure 'capital scarcity' *at opening* by the following ratio:

$$\text{`capital scarcity'}(i, t_i) = \frac{k_{i,t_i}}{k^*_{t_i}}$$

A ratio smaller than 1 indicated that at time of opening, country i has a lower capital stock per-efficiency unit than developed countries. Note that the use the word scarcity is a bit of a language abuse since in a stochastic environment as ours, country i can have a higher capital stock than developed countries and still be below its own autarky steady-state.

We measure the average capital scarcity at time of opening of a considered group of countries by computing the arithmetic average of $k_{i,t_i}/k^*_{t_0}$ across countries i belonging to the group (region or set of emerging liberalizing countries).[30] Figure B.2 reports the degree of capital scarcity at time of opening for each group of countries. At time of opening, liberalizing emerging countries have on average a capital stock very close to 50% of the one of developed countries, in line with our baseline calibration. There is some heterogeneity though with Southern Europe being much more capital abundant at opening than Asia or Middle-Eastern countries.

[30]GDP-weighted (using GDPs in 1990) averages gives very similar results quantitatively.

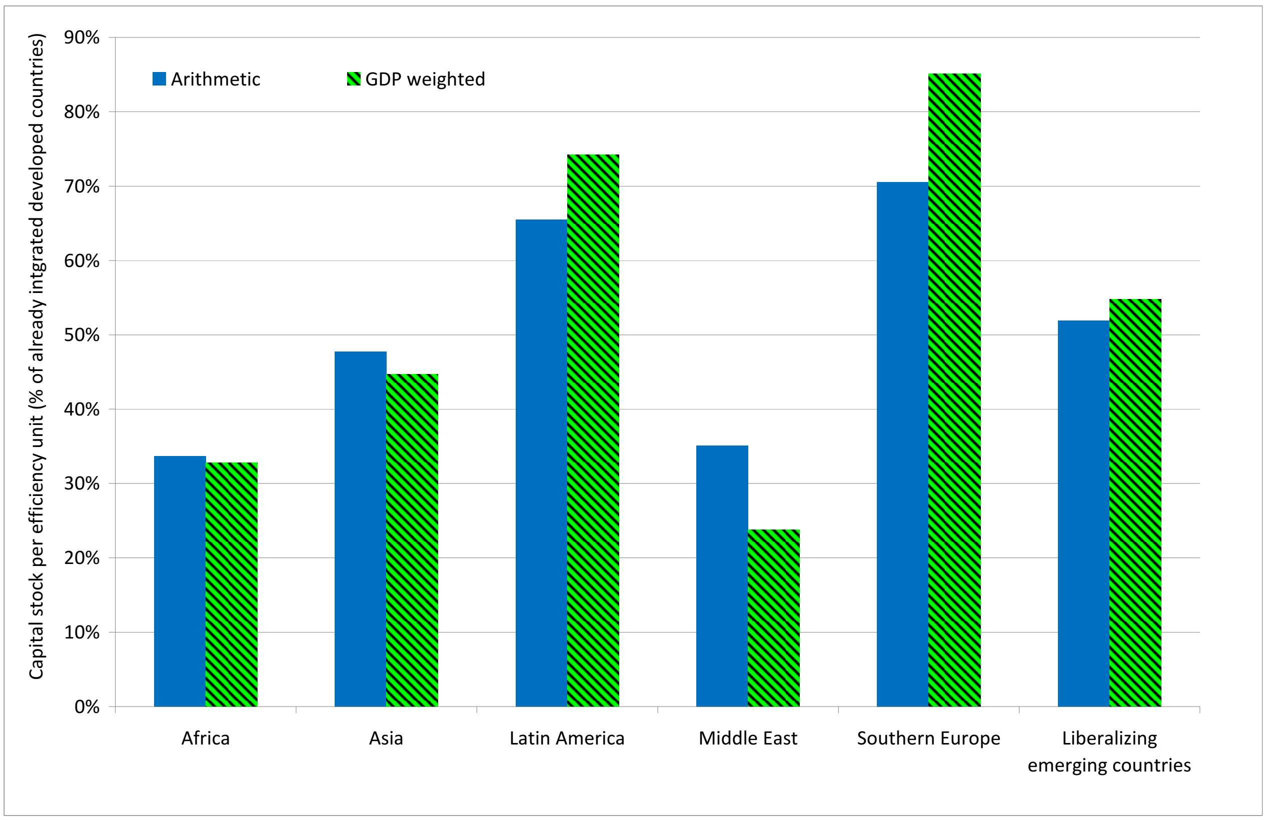

Figure B.2: Degree of 'capital scarcity' at time of opening across emerging liberalizing countries.

Notes: Penn World Tables. Capital scarcity of a given region at time of opening is the average (arithmetic or GDP-weighted) across countries i in the region of $k_{i,t_i}/k^*_{t_i}$. k_{i,t_i} (resp. $k^*_{t_i}$) denotes the capital per efficiency units in country i (resp. the set of developed countries) at time of opening. The sample of countries is described in Section B.1. GDP weights for the average scarcity across countries in a group are based on 1990 GDPs.