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International Risk-Taking, Volatility, and Consumption Growth*

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Abstract

We provide evidence that higher international risk-taking leads to higher expected consumption growth. International risk is measured through the regression coefficient or *beta* of a country's consumption growth with world consumption growth. We find that a one-standard-deviation increase in beta increases consumption growth by 40 basis points over the next five years. Unlike beta, higher volatility (total or idiosyncratic) has a negative effect on growth. Countries with higher betas have larger stocks of foreign assets, while countries with higher volatility have smaller stocks of foreign assets.

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This paper examines the risk-taking aspect of financial integration and its impact on consumption growth.[1] Obstfeld (1994a) shows that greater risk-taking can increase expected consumption growth and consequently the welfare gains from participating in international financial markets. Although this theoretical point is well-established, the empirical evidence documenting the growth benefits of financial integration and international risk-taking is still ambiguous. For instance, Bekaert, Harvey, and Lundblad (2005) find that equity market liberalizations exert a positive influence on future growth, while Edison et al. (2002) conclude that financial integration broadly speaking does not accelerate growth. With respect to the connection between financial integration and risk-taking, most studies look at growth volatility as proxy for risk, and while some find a dampening effect of financial integration on volatility (Bekaert, Harvey, and Lundblad (2006)), others argue that the evidence is not yet decisive (Kose, Prasad, and Terrones (2006)). Finally, the link between risk-taking, proxied by volatility, and growth seems weak at best. The conventional wisdom following Ramey and Ramey (1995) is that the empirical correlation between volatility and growth is in fact negative. In this paper we provide new evidence in favor of a connection between financial integration, risk-taking, and growth, and we reconcile it with some of the previous empirical findings.

Our perspective on risk-taking is rooted in the same theoretical underpinnings as the Capital Asset Pricing Model (CAPM). The CAPM predicts that riskier assets–those that covary more with the market–yield higher average returns as a reward for risk. In an analogous way, we measure risk-taking through the regression coefficient of a country's consumption growth on the world's consumption growth. We call this coefficient a country's *beta*. A high beta implies that a country takes on a riskier international position, which yields higher expected consumption growth as a reward for that risk.

To distinguish between beta and volatility, we extend Obstfeld (1994a)'s model to the case

[1] In theory, financial integration can affect growth not only through improved risk-taking, but also through an increased flow of foreign capital. This channel can be studied in a neoclassical growth model without uncertainty or risk (see Gourinchas and Jeanne (2006)).

of incomplete markets.[2] An important implication of incomplete markets is that consumers have to bear risks that they cannot insure or trade. As a result, not all risks are actively taken by consumers, and thus volatility is not a synonym for risk-taking. The positive relationship between risk and growth predicted by the theory refers to active risk-taking, i.e., beta in our setup. Volatility, on the other hand, includes risk-taking plus the involuntary exposure to other shocks (good and bad "luck"). Precisely because of this separation between risk-taking and volatility, the model opens up the door for a negative effect of volatility on growth as is found empirically, although from the model we cannot unambiguously conclude that the effect of volatility is always negative or positive.

We explore the relationship between the two risk measures and growth in a panel data set with 74 countries from 1960 to 2000. Higher betas are coupled with a reward in terms of expected consumption growth. Our regressions indicate that a one-standard-deviation increase in beta increases average consumption growth by 40 basis points over the following five years. At the same time, we confirm the negative effect of volatility on growth originally identified by Ramey and Ramey (1995). A one-standard-deviation increase in volatility decreases average consumption growth by 50 basis points over the following five years. We find that beta is positively correlated with the stock of foreign assets accumulated by the country (taken from Lane and Milesi-Ferretti (2001)), as predicted by the theory. Volatility, on the other hand, is negatively correlated with foreign assets. These correlations imply that financial integration and risk are indeed positively associated when thinking of betas and not volatility.

Beyond the literature on financial integration, our results are interesting from the perspective of the empirical growth literature. Beta and idiosyncratic volatility are two powerful predictors of per capita consumption growth, particularly at medium-run horizons (3 to 10

[2] Complete markets are widely rejected in empirical studies of risk-sharing across countries. See Lewis (1999) for a survey of international risksharing. Backus, Kehoe, and Kyland (1992), Lewis (1996), and Obstfeld (1994b), among others, document the failure of perfect international risksharing. Cochrane (1991) and Mace (1991) perform tests of perfect risksharing within the U.S. For welfare gains of risksharing see, for example, Athanasoulis and Shiller (2001), Athanasoulis and van Wincoop (2000), Obstfeld (1994a), and van Wincoop (1999).

years). These risk measures have forecasting power above and beyond traditional growth determinants such as initial income, the ratio of investment to GDP, and measures of human capital. After controlling for beta, volatility, and other country characteristics we still observe conditional convergence, i.e., high initial income forecasts low subsequent growth (Barro (1991)). One advantage of beta as a growth predictor is that it is not highly correlated with income levels, unlike most traditional variables. The high correlation of other variables with income introduces multicollinearity problems in cross-country regressions (Levine and Renelt (1992), Mankiw (1995)). We show that, although rich countries have slightly higher betas on average when compared to less developed countries, the spread in betas is much wider in less developed countries. Therefore, a high beta is not necessarily an indication of a high-GDP country. In contrast, the effect of volatility is harder to disentangle from the effect of income because volatility and income are highly and negatively correlated (Acemoglu and Zilibotti (1997), Koren and Tenreyro (2007)).

An important caveat concerns the relation between our results and consumption-based asset pricing. Our results could be interpreted as testing risk-return trade-offs without return data, as the behavior of asset returns is simply the flip side of the tests that we perform. Despite the fact that our results are in line with the theory, we cannot escape the standard asset pricing puzzles if we define the portfolio of tradable assets in terms of stock market wealth (Campbell (2003)). First, international stock markets are too volatile compared to the volatility of world consumption. Both volatilities should be the same according to the model. Second, the growth effect of beta looks too small compared to the risk premium observed in stock markets. This is a reflection of the equity premium puzzle. Given the focus on welfare gains of integration, we prefer to study consumption growth directly rather than asset prices. Also, the tests with returns suffer from other shortcomings, not least the unobservability of the market portfolio.

The paper is organized as follows. Section 1 derives the relationships between beta, volatility, and expected consumption growth in an incomplete-markets model. Section 2 describes the main data sources and measurement issues. Section 3 presents the basic results, plus the examination of other standard determinants of growth across countries. Section 4 digs deeper into the measures of risk by correlating them with the foreign asset position of a country and economic development. Section 5 concludes. The appendix contains robustness checks and supplementary data.

1 A Model of International Risk-Taking and Consumption Growth

The finance literature has a long tradition of testing and identifying risk-return trade-offs. The CAPM implies that stocks that have a high beta with the market should yield high average returns. This paper follows that tradition, but it correlates a country's consumption growth, and not asset returns, with a measure of risk-taking. Both ideas are related. Higher risk-taking fuels average consumption growth precisely because risky technologies yield higher average returns. Obstfeld (1994a) was the first to apply this fundamental intuition of finance to the study of the benefits of international financial integration. By following the risk-return tradition this paper highlights the connection between average growth and risk or, equivalently, between first and second moments of the growth distribution.

We present mostly analytical solutions of the model based on the techniques developed by Campbell and Viceira (2002). This maximizes the intuition, although at some costs in terms of generality. For example, we exogenously specify that non-insurable shocks follow an AR(1) process. We hope that the loss of generality is compensated by the tractability of the model. We also believe that the main results of the model carry on to more general settings.

1.1 Equilibrium in Financial Autarky

We set up a portfolio model in the style of Merton (1971, 1973). We first consider the behavior of an infinitely-lived representative investor in financial autarky that can only invest in a domestic risky asset and borrow/lend using a domestic bond.

Lifetime utility is characterized by Duffie-Epstein (1992a,b) preferences:

$$J_0 = E_0\left(\int_0^\infty f(C_t, J_t)dt\right), \tag{1}$$

where $f(C_t, J_t)$ is a function that aggregates consumption (C_t) and continuation utility (J_t). This function takes the form

$$f(C, J) = \frac{\delta(1-\gamma)J}{1-1/\psi}\left[\left(\frac{C}{((1-\gamma)J)^{1/(1-\gamma)}}\right)^{1-1/\psi} - 1\right]. \tag{2}$$

Under this specification δ is the subjective discount rate, γ is the coefficient of relative risk aversion, and ψ is the elasticity of intertemporal substitution.

Returns on the riskless bond (B) and the risky asset (P) follow one-dimensional Ito processes with constant drift and volatility parameters. Uncertainty is captured by the term dz_p, which is a standard Brownian motion:

$$\frac{dB}{B} = rdt, \tag{3}$$

$$\frac{dP}{P} = \mu_p dt + \sigma_p dz_p. \tag{4}$$

The investor also receives income from non-financial sources. We can imagine that this income represents wages, income from an entrepreneurial business, or government transfers. For our purposes, the two important properties of non-financial income are the following: 1) It provides consumption opportunities on top of those given by returns on financial investment, and (2) Its stochastic behavior cannot be captured with financial assets, i.e., markets are incomplete. We assume that non-financial income dy behaves according to

$$
\begin{aligned}
dy &= \phi s W dt, && (5) \\
ds &= \lambda(\varsigma - s)dt + \sigma_s dz_s. && (6)
\end{aligned}
$$

A simple way to interpret equation (5) is that every period the investor receives a windfall of cash equal to the fraction s of wealth (imagine that $\phi = 1$ for simplicity). This fraction s follows an Ohrnstein-Uhlenbeck or continuous-time AR(1) process. The process in (6) does not prevent s from taking negative values, which would imply that the investor loses a fraction s of wealth. The correlation between dz_p and dz_s is zero, or in other words, the uncertainty related to s cannot be hedged with financial assets. The parameter ϕ measures the sensitivity of the investor's non-financial income to the state variable s. Setting $\phi = 0$ is equivalent to assuming that markets are complete, because the risk related to s becomes irrelevant to the investor.

Let k be the fraction of wealth allocated to the risky asset. This fraction can be negative if the investor sells short the risky asset, or it can be larger than 1 if the investor takes on leverage to invest more in the risky asset. The change in wealth during an interval dt is

$$
\begin{aligned}
dW &= (1-k)W\frac{dB}{B} + kW\frac{dP}{P} - Cdt + dy \\
&= [(1-k)Wr + kW\mu_p - C + \phi s W]dt + kW\sigma_p dz_p. && (7)
\end{aligned}
$$

The optimization problem consists in choosing the paths of consumption and portfolio allocations that maximize (1), subject to the dynamic budget constraint and a given level of initial wealth and the state variable. Let $J(W, s)$ denote the maximum level of lifetime utility as a function of wealth and the state variable. The Bellman equation for this problem is

$$0 = \max_{\{C,k\}} \left\{ \begin{array}{c} f(C,J) + J_W[(1-k)Wr + kW\mu_p - C + \phi sW] + J_s\lambda(\varsigma - s) \\ + \frac{J_{WW}}{2}k^2W^2\sigma_p^2 + \frac{J_{ss}}{2}\sigma_s^2 \end{array} \right\}. \tag{8}$$

From the first order conditions of this equation we can express C and k as

$$C = (1-\gamma)\delta^{\psi} J_W^{-\psi} J^{\frac{1-\gamma\psi}{1-\gamma}}, \tag{9}$$

$$k = \frac{-J_W}{WJ_{WW}} \left(\frac{\mu_p - r}{\sigma_p^2} \right). \tag{10}$$

The problem is isomorphic to the model studied by Campbell and Viceira (2002, section 5.3). A closed-form solution for the value function does not exist except for two special cases: when markets are complete ($\phi = 0$) and when the elasticity of intertemporal substitution is unitary.[3] These cases have the practical disadvantage that consumption does not respond to unhedgeable risks in equilibrium. For the general case, Campbell and Viceira guess the following solution for the value function

$$J(W,s) = H(s)^{-((1-\gamma)/(1-\psi))} \frac{W^{1-\gamma}}{1-\gamma}, \tag{11}$$

where $H(s)$ is some function of s to be determined. With this guess the optimal consumption and portfolio rules become

$$\frac{C}{W} = \delta^{\psi}(1-\gamma)^{-(\gamma(1-\psi)/(1-\gamma))} \frac{1}{H}, \tag{12}$$

[3] In complete markets ($\phi = 0$) the value function takes the form $J = (AW)^{1-\gamma}/(1-\gamma)$, where A is a constant. When the elasticity of intertemporal substitution is equal to 1 the aggregator $f(C,J)$ takes the form
$f(C,J) = \delta(1-\gamma)J\left[\log C - \frac{1}{1-\gamma}\log((1-\gamma)J)\right]$. In this case, the value function in (11) with $H(s) = \exp(A_1 - A_2 s)$ is the exact closed-form solution to the problem.

$$k = \frac{\mu_p - r}{\gamma \sigma_p^2}. \tag{13}$$

The portfolio allocation is the same as in the complete-markets case, which is a result of the inability to hedge movements in non-financial income with financial assets. Once we substitute these results back into the Bellman equation we obtain a differential equation for $H(s)$ that cannot be solved in closed form. The key obstacle to solve this equation is in the terms with $1/H(s)$. In order to deal with this problem Campbell and Viceira propose a log-linear approximation of the consumption-wealth ratio (equation (12)) around its unconditional mean. Let $c - w = \log(C) - \log(W)$, then

$$\frac{C}{W} = \exp(c - w) \approx h_0 + h_1(c - w) = h_0 + A_0 - h_1 \log(H(s)), \tag{14}$$

where $h_0 = \exp(E(c-w))[1 - E(c-w)]$, $h_1 = \exp(E(c-w))$, and A_0 includes constants from the log version of equation (12). Once we substitute this approximation for terms with $1/H(s)$ in the differential equation mentioned above, it is easy to show that $H(s) = \exp(A_1 - A_2 s)$, with $A_2 = \phi(1-\psi)/(h_1 + \lambda)$, is a solution.[4] Therefore, the approximate expression for log-consumption is

$$c = A_0 - A_1 + w + \left(\frac{\phi(1-\psi)}{h_1 + \lambda} \right) s. \tag{15}$$

The approximation is good if ψ remains close to 1, or in other words, if the consumption-wealth ratio does not fluctuate too much. We assume throughout the paper that we stay in the vicinity of $\psi = 1$. As $\psi \to 1$ the consumption-wealth ratio becomes a constant equal to δ as in the case with unitary elasticity of substitution.

In terms of dynamics, equation (15) implies that log-consumption behaves approximately as $dc = dw + A_2 ds$. The ultimate goal of the model is to understand consumption growth, which can be written in general form as

[4] A_1 is a function of the rest of the parameters in the model.

$$\frac{dC}{C} = gdt + \sigma_{cp} dz_p + \sigma_{cs} dz_s, \tag{16}$$

where g is the instantaneous expected growth rate of consumption. The dynamics of log-consumption imply that the approximate solution for these parameters is

$$\begin{aligned} g &= \left[(\mu_p - r)k + r - \eta(s) + \phi s + A_2 \lambda (\varsigma - s) + \frac{A_2^2 \sigma_s^2}{2} \right], & (17) \\ \sigma_{cp} &= k \sigma_p, & (18) \\ \sigma_{cs} &= A_2 \sigma_s, & (19) \end{aligned}$$

where $\eta(s)$ is the optimal consumption-wealth ratio in equation (12).[5]

We write g as a function of the (endogenous) fraction invested in the risky asset in order to emphasize the positive relation between risk-taking and expected consumption growth (conditional on the existence of an equity premium $\mu_p > r$). The other factors that affect expected growth are all related to unhedgeable risks. However, the net effect of unhedgeable risks is not obvious. For example, while it seems intuitive that a positive ϕ increases expected consumption growth, it really depends on the elasticity of intertemporal substitution ($\psi \gtreqless 1$), on whether the state variable is above or below the mean-reversion parameter ς, and on the sign of the state variable. If the elasticity of intertemporal substitution is low ($\psi < 1$) and if s is expected to grow ($\varsigma > s > 0$), then the term $\phi s + A_2 \lambda (\varsigma - s)$ is positive and we get that a positive ϕ is most likely associated with higher growth. But other combinations are also possible. The term $A_2^2 \sigma_s^2 / 2$ is always positive and it represents a Jensen's inequality adjustment. The consumption-wealth ratio $\eta(s)$ also depends on ϕ, although for values of ψ close to one the effect is small.

When markets are complete ($\phi = 0$), the consumption-wealth ratio becomes a constant.[6]

[5] In order to derive these expressions we also use the following property: if a variable X follows the process $\frac{dX}{X} = \mu_x dt + \sigma_x dZ$, then $dx \equiv d \log X = (\mu_x - \frac{\sigma_x^2}{2}) dt + \sigma_x dZ$.

[6] In complete markest the consumption-wealth ratio is $\frac{C}{W} = \psi \left[\delta - (1 - \frac{1}{\psi}) \left(r + \frac{(\mu - r)^2}{2 \gamma \sigma^2} \right) \right]$.

In this case, expected growth can be written as

$$g^{complete} = \psi(r-\delta) + \frac{(1+\psi)}{2}(\mu_p - r)k. \tag{20}$$

In both complete and incomplete markets we see a positive relationship between risk-taking (basically, the inverse of risk aversion) and expected growth. Investors with lower risk aversion take more advantage of risky technologies with higher returns, which explains their higher average consumption growth.[7]

Equations (18) and (19) illustrate the connection between first and second moments of consumption growth. The first element, σ_{cp}, captures active risk-taking. The second element, σ_{cs}, captures the sensitivity of consumption to unhedgeable shocks, which enters expected consumption growth through the last term in equation (17). Empirically it is a challenge to separate σ_{cp} from σ_{cs} in consumption fluctuations. For example, total consumption volatility is the sum of both components, $\sigma_{cp}^2 + \sigma_{cs}^2$. The next sections illustrate one way of obtaining a "clean" measure of risk-taking from consumption fluctuations that is rooted in the CAPM.

To complete the characterization of the equilibrium in autarky we need to specify the market clearing condition. Following Cox, Ingersoll, and Ross (1985), we assume that bonds are in zero net-supply, or in other words, the interest rate is such that the representative agent does not borrow nor lend in equilibrium. By setting $k = 1$ in equation (13) we obtain the equilibrium interest rate in autarky,

$$r^{autarky} = \mu_p - \gamma\sigma_p^2.$$

[7] This analysis ignores the effect of risk aversion on the consumption-wealth ratio $\eta(s)$ in the case of incomplete markets. Risk aversion can lead to a higher or lower ratio depending on ψ, and consequently affect expected consumption growth also through this indirect channel. This effect is bound to be small given that we consider values of ψ in the vicinity of 1. If the elasticity of intertemporal substitution is unitary the consumption-wealth ratio is equal to δ in equilibrium.

1.2 Equilibrium in a Multi-Country Economy with Incomplete Markets

We assume that each country has a representative investor with Duffie-Epstein preferences. We use γ_j to denote the risk aversion coefficient of the representative investor in country j $(j = 1, ..., N)$.[8] The elasticity of intertemporal substitution and the rate of time preference are assumed to be the same across countries.[9]

There are N risky country-technologies that are tradable worldwide, i.e., financial markets are fully integrated. Each technology behaves like in equation (4) with expected return μ_{pj}, instantaneous variance σ_{pj}, and shock dz_{pj}. We maintain the assumption that the correlation between tradable assets and non-financial risks is zero. The $N \times 1$ column vector of expected returns is denoted by $\boldsymbol{\mu}$. The variance-covariance matrix of these assets is $\boldsymbol{\Sigma}$, which is assumed to be invertible.

Every country can lend and borrow freely at the world interest rate r^*. Therefore, the demand for risky securities of the representative investor in country j is

$$\mathbf{k}_j = \boldsymbol{\Sigma}^{-1}(\boldsymbol{\mu} - r^*\mathbf{1})/\gamma_j, \tag{21}$$

where $\mathbf{1}$ is an $N \times 1$ vector of ones. Equation (21) implies that all investors hold risky assets in the same proportions. The ratio of risky to risk-free investments is decreasing in the risk aversion of each investor, but the relative weights in the portfolio of risky investments remain constant across investors. This corresponds to the mutual-fund theorem, first noted by Tobin (1958) and then by Merton (1973) in a continuous-time model. The vector of weights in the global mutual fund is

[8] Many papers assume that risk aversion is the same across countries, which effectively shuts down differences in risk-taking. Allowing for heterogeneity in risk aversion does not change the basic implication of complete markets—that the correlation of individual consumption and aggregate consumption is perfect. However, if risk aversion varies, the volatility of each country and the world are not the same anymore. This heterogeneity in risk aversion can be a source of misspecification in previous empirical studies of consumption risksharing. See also Mazzocco and Saini (2006).

[9] Yogo (2004) reports that estimates of the elasticity of intertemporal substitution are small and not significantly different in eleven developed countries, which is supporting evidence for this assumption,.

$$\boldsymbol{\theta} = \boldsymbol{\Sigma}^{-1}(\boldsymbol{\mu} - r^*\mathbf{1})/\mathbf{1}'\boldsymbol{\Sigma}^{-1}(\boldsymbol{\mu} - r^*\mathbf{1}). \tag{22}$$

The weight of each risky asset in the global mutual fund is denoted by θ_j. The mutual fund theorem allows us to use the formulas from the two-asset case by defining the expected return and variance of the global mutual fund as $\mu_p^* = \boldsymbol{\theta}'\boldsymbol{\mu}$ and $\sigma_p^{*2} = \boldsymbol{\theta}'\boldsymbol{\Sigma}\boldsymbol{\theta}$.[10] The fraction of wealth that the representative investor of country j puts in the global mutual fund is k_j^*.

The global shock dz_p^* is the sum of all financial shocks, and it is assumed to be uncorrelated with non-financial risks dz_{sj}. This assumption implies that, in our model, financial integration does not provide hedging opportunities for local non-financial risks. We shut down this possibility to emphasize the role of risk-taking even in the absence of a risk-sharing channel that would only add to the benefits of financial integration.[11]

The formulas for consumption dynamics are the same as before replacing k_j^* for k and adding the subscript j to the parameters that describe unhedgeable shocks. We define $A_{2j} = \phi_j(1-\psi)/(h_{1j} + \lambda_j)$. This implies that in our model the cross-country variation is given by γ_j (risk-taking) and the severity of unhedgeable risks.

The market-clearing condition that determines the world interest rate is

$$\sum_{j=1}^{N}(1 - k_j^*)W_j = 0, \tag{23}$$

or in other words, there is no net borrowing or lending in the aggregate. In equilibrium, some countries are net borrowers and some countries are net lenders depending on their risk aversion, but long and short positions in the risk-free asset cancel out once we aggregate them. Investors with low risk aversion, who want to invest more than 100% of their wealth

[10] We have not mentioned short-sale constraints in this analysis. It may be the case that investors want to short some risky technology ($\theta_j < 0$), which is not possible in equilibrium. A risky technology under these circumstances will shut down and wealth will be allocated to other assets. We can assume that $M < N$ technologies remain open in equilibrium, in which case all of the analysis above applies by defining the mutual fund over those M assets. The definitions of θ_j, μ_p^*, and σ_p^{*2} are analogous.

[11] Improved risk-sharing opportunities can explain the dampening effect of financial integration on consumption volatility as suggested by Bekaert, Harvey, and Lundblad (2006).

in the global mutual fund, will borrow from more risk averse foreigners at the world interest rate.

We make a final assumption that relies on a CAPM-like intuition. We assume that unhedgeable risks are idiosyncratic in nature, or in other words, they wash out in the aggregate of countries.[12] More specifically, shocks satisfy

$$\sum_{j=1}^{N} W_j \sigma_{csj} dz_{sj} = 0. \tag{24}$$

Let world consumption growth be a the wealth-weighted sum of country growth rates:

$$\frac{dC^*}{C^*} = \sum_{j=1}^{N} \frac{W_j}{W^*} \frac{dC_j}{C_j} = g^* dt + \sigma_p^* dz_p^*, \tag{25}$$

where $\sum_{j=1}^{N} W_j \equiv W^*$. Our assumption implies that unhedgeable shocks, or terms with dz_{sj}, are not reflected in world consumption.

In our model we simply assume the idiosyncratic nature of unhedgeable or financially unrewarded shocks. But this CAPM-like intuition can be derived in a formal model where the menu of assets available and their coverage of risks is endogenized. Athanasoulis and Shiller (2000) show that, from the point of view of a benevolent market-maker with imperfect information, the most important asset to create is the one that spans aggregate fluctuations rather than idiosyncratic fluctuations. In other words, aggregate risks are the primary risks that are priced by financial markets and not idiosyncratic risks.

1.3 Beta, Volatility, and Growth

We define β_j as a measure of comovement between country growth and world growth,

$$\beta_j = \frac{Cov\left(\frac{dC_j}{C_j}, \frac{dC^*}{C^*}\right)}{Var\left(\frac{dC^*}{C^*}\right)}. \tag{26}$$

[12] We can think, for example, of the shocks induced by outsourcing and how a negative labor shock in the U.S. is compensated by a positive labor shock in China.

Beta is the regression coefficient of country consumption growth on world consumption growth. It is easy to show that in our model $\beta_j = k_j^*$, which implies that a country's beta measures international risk-taking or how much world risk the country holds in its portfolio.

We can rewrite expected consumption growth in equation (17) as a function of the country's beta by replacing k_j^* with β_j:

$$g_j = \left[(\mu_p^* - r^*)\beta_j + r^* - \eta_j(s_j) + \phi_j s_j + A_{2j}\lambda_j(\varsigma_j - s_j) + \frac{\sigma_{csj}^2}{2} \right] \tag{27}$$

Equation (27) leads to our main hypothesis: *in a cross-section of countries, those with higher betas have higher consumption growth on average* (ceteris paribus). This is a formal expression of the idea that risk-taking and expected consumption growth are positively related.

Total consumption volatility is given by $\sigma_{cpj}^2 + \sigma_{csj}^2$, where $\sigma_{cpj}^2 = k_j^{*2}\sigma_p^{*2}$ and $\sigma_{csj}^2 = A_{2j}^2\sigma_{sj}^2$. Therefore, volatility measures risk-taking through its first term, but it also includes the response of consumption to unhedgeable shocks in its second term. By computing beta we are able to "clean" the component of the volatility that is due to unhedgeable risks and that is unrelated to the country's active risk-taking.

Under our assumptions, σ_{csj}^2 also corresponds to idiosyncratic volatility, which is defined as the volatility of consumption fluctuations that are uncorrelated with world consumption growth. Idiosyncratic volatility has a positive effect on growth as seen in the last term of equation (27). However, the same parameters that cause the cross-country variation in idiosyncratic volatility also enter equation (27) through other terms that can offset the positive effect of volatility. This inter-dependence implies that, as with ϕ_j itself for example, it is not possible to determine unambiguously whether idiosyncratic volatility will have a positive or negative coefficient in a growth regression. The easiest way to see this is that volatility does not tell us about the sign of ϕ_j, i.e. the average impact of unhedgeable shocks. Countries with large ϕ_j's, positive or negative, have high volatility, but not necessarily high expected growth.

In Obstfeld (1994a)'s model it is also the case that $\beta_j = k_j^*$. However, under complete markets, consumption volatility only includes the term $\sigma_{cpj}^2 = k_j^{*2}\sigma_p^{*2}$, and therefore beta and volatility become indistinguishable. Under the assumption of complete markets, beta would be the only source of cross-country variation in expected consumption growth. As seen in equation (27), our model opens up the door for other country-specific factors (terms with subscript j) that can affect growth.

Tests of risk-sharing under complete markets are tests of $\sigma_{csj} = 0$ (see Cochrane (1991), Lewis (1996), Mace (1991) and Obstfeld (1994b)). No fluctuation in consumption should be independent of aggregate fluctuations if markets are complete, or in other words, the correlation between country growth and world growth should be perfect. In our model, the correlation coefficient between country and world fluctuations is,

$$\rho_j = \frac{k_j^*\sigma_p^*}{\sqrt{k_j^{*2}\sigma_p^{*2} + \sigma_{csj}^2}}. \tag{28}$$

The correlation can be well below 1 if unhedgeable shocks are large. The correlation can also be positive or negative depending on the sign of k_j^*. We obtain a perfect correlation if the elasticity of intertemporal substitution is equal to one or if the country is not subject to unhedgeable shocks ($\phi_j = 0, \sigma_{sj} = 0$). In general, the correlation will not be perfect.

Unlike tests of perfect risk-sharing, our hypothesis does not refer to *actual* consumption growth, but to *expected* consumption growth and its connection to risk. It is a test about the relation between first and second moments of the growth distribution, and not only about second moments.

2 Data and Measurement

2.1 Sources and Requirements

We rely primarily on data from the Penn World Table 6.1 (PWT) with annual coverage from 1950 to 2000. We limit our sample to countries with the following characteristics: (1) data quality must equal grade C or above; (2) at least 15 years of continuous data must be available; (3) average population must be greater than 2 million (with the exception of Luxembourg and Iceland); and (4) average PPP-adjusted per capita GDP for the country must be greater than $1,000. This selection process yields a data set with 74 countries listed in the appendix. From the PWT we take real per capita consumption calculated as a product of real PPP-adjusted per capita GDP (PWT mnemonic `rgdpl`) and the consumption share (PWT mnemonic `kc`). For robustness purposes we use data on real per capita consumption from 1960 to 2004 from the World Development Indicators (WDI) database. These data are not PPP-adjusted, so we can strip off the effects of price changes on consumption growth.

Following previous literature on cross-country growth differences, we also investigate the forecasting power of fertility (found in WDI), the investment share of GDP (PWT mnemonic `ki`), and secondary school enrollment (Barro and Lee (2001)).[13] The measures of foreign assets and liabilities are taken from Lane and Milesi-Ferretti (2001).

2.2 Estimation of Beta and Volatility

We measure beta from the following regression,

$$\Delta c_{j,t-\tau} = \alpha_{j,t} + \beta_{j,t} \Delta c^*_{t-\tau} + \varepsilon_{j,t-\tau}, \tag{29}$$

where $\tau = 0, 1, ..., T$. Per capita consumption growth is defined as $\Delta c_{t-\tau} = (c_{t-\tau}/c_{t-\tau-1}) -$

[13] Some countries report secondary enrollment only at 10-year intervals. For the regressions with 5-year intervals we fill the gaps taking the average of the two adjacent observations (e.g., if the country reports data for 1970 and 1980, we create an observation for 1975 equal to the average of the observations in 1970 and 1980). Secondary enrollment moves slowly so it is probably safe to do the linear interpolation.

1, and world growth is represented by Δc^*.[14] Since a country's wealth is not directly observable, world consumption growth is measured as the total-consumption weighted average of per capita growth rates. Total consumption equals the product of real per capita consumption and population.

We allow for a time-varying beta in order to capture potential slow-moving variation in the structural parameters of the model (e.g., expected returns, volatilities, and others). We use a backward-looking window to estimate beta at time t for each country. This is the standard way of computing betas in the finance literature (for example, Fama and MacBeth (1973), Fama and French (1992)). We settle on a 10-year estimation window ($T = 9$) as a result of two opposing forces. On one hand, we want a time-varying measure of a country's risk-taking position; if we use too long an estimation window, beta becomes constant. On the other hand, the shorter the estimation period, the more sensitive beta is to measurement error and outliers. Therefore, some smoothing is necessary to obtain a better estimate of the real beta. In the appendix we show robustness checks with different estimation windows.

We define the idiosyncratic volatility of consumption as the standard deviation of the residuals in equation (29). We denote this volatility by $\sigma^{\varepsilon}_{j,t}$. Since the PWT starts in 1950, our measures of beta and idiosyncratic volatility are available since 1960.

2.3 Descriptive Statistics

Table I presents descriptive statistics for all variables employed in our analysis. Means of consumption growth at different horizons are all about 2.2%, but measures of variability decrease as we extend the horizon. The standard deviation of consumption growth decreases by almost two-thirds from the 1-year to 10-year horizon. The mean beta equals 0.75 and the mean idiosyncratic volatility equals 4.78%. The dispersion of these risk measures is large as seen by their respective standard deviations (2.6 and 3.5%).

Figure 1 shows world consumption growth and world volatility. World volatility has

[14] We work with simple growth rates and not log differences to avoid problems with Jensen's inequality. Results are very similar if we use log differences.

declined since the mid-1980s as also observed by Stock and Watson (2005). Figure 2 shows the time-series of cross-sectional medians of beta and idiosyncratic volatility. The median beta is also around 0.75 across years. There is a decline in beta after 1990 indicating a drop in the median exposure to world risk. The decline in beta coincides with a declining correlation between national and world consumption. The plot of idiosyncratic volatility shows initially an upward-sloping trend in volatility; however, the last panel with the number of countries suggests that the jump in volatility in the 1960s is most probably caused by the addition of countries to the sample. After 1970 there is no trend or the trend is only slightly upward-sloping. It follows from equation (28) that the decline in correlation in the 1990s is explained by a decline in risk-taking (β_j or k_j^*) and world risk (σ_p^*) rather than by an increase in idiosyncratic volatility (σ_{csj}^2).

Beta and total volatility are not highly correlated in the cross-section of countries (correlation=0.15). But the lack of linear dependence can be misleading. In fact, the pattern relating beta and volatility has a u-shape: countries with low and high betas have high volatility, and countries with medium-size betas have relatively low volatility (See figure 3). This illustrates the fact that beta retains the sign of risk-taking (k_j^*). This property of beta is crucial for understanding its impact on growth. Volatility, on the other hand, is proportional to k_j^{*2} and σ_{csj}^2, and therefore, it does not indicate the direction of risk-taking or the sign of the sensitivity to unhedgeable shocks.

3 Results

3.1 Regression Analysis

We are interested in the effect of beta on expected consumption growth. A positive effect of beta means that world risk is rewarded. In order to get a clean empirical estimate we need to control for the other country-specific factors in equation (27). We include idiosyncratic volatility (and also other variables) that can capture these cross-country differences unrelated to beta. In most regressions we also use country fixed effects to capture any unobservable, time-invariant country effect on expected growth.

The basic panel regression that we run is

$$\Delta c_{j,t+h} = b_1 \beta_{j,t} + b_2 \sigma^{\varepsilon}_{j,t} + \varkappa_t + \pi_j + \zeta_{j,t}. \tag{30}$$

We look at the power of beta and idiosyncratic volatility computed at time t to predict consumption growth at several horizons. We start with consumption growth from year t to $t+1$. Then we extend the forecasting horizon by looking at the annualized consumption growth from year t to $t+h$, where $h = \{3, 5, 10\}$. The intervals for growth observations do not overlap so regressions with longer horizons have fewer observations. All regressions include time fixed effects ($\varkappa_t$), and some regressions include country fixed effects (π_j). We allow for heterogeneity in $\zeta_{j,t}$. We also consider clustering standard errors by country. This can correct, at least partially, for the serial correlation in residuals introduced by estimation error in beta and volatility. Measurement error can persist for several periods since beta and volatility are estimated with overlapping windows (except for $h = 10$). We do not allow residuals in a period to be correlated across countries, because this produces biased standard errors due to the small number of clusters at the 5-year and 10-year horizons (Petersen (2006)).

Table II presents regressions at different horizons and with different specifications. At the 1-year horizon it is hard to find significant coefficients given the large fluctuations of consumption. The positive coefficient of beta increases up to the 5-year horizon, when significance is also strongest, and then it comes down in the 10-year regression. The magnitude of this coefficient implies that a one standard deviation shock in beta increases average consumption growth by 30-40 basis points (5-year horizon estimates).

According to equation (27) the coefficient on beta is equal to the risk premium on the global mutual fund of tradable assets. If we equate the global mutual fund with international stock markets then the problem is that the coefficients we obtain are too small compared to average excess returns in those markets. This is just another way of stating the equity premium puzzle: stocks yield returns that are too high when contrasted with consumption data. It is hard to draw comparisons with returns on a more broadly defined mutual fund that also includes bonds, derivatives, FDI, real estate, and other risky investments.

The negative coefficient on volatility is larger in absolute sense at the 3-year horizon, and then it declines as the horizon is extended. The magnitude of this coefficient implies that a one standard deviation shock in idiosyncratic volatility lowers average consumption growth by 40-50 basis points (5-year horizon estimates). Total and idiosyncratic volatility increase together, therefore table II confirms the finding in Ramey and Ramey (1995) that volatility is bad for growth.

The country fixed effects do not have a big impact on the coefficients of beta and volatility, which can be expected if there is substantial variation within country in these variables. If anything, coefficients increase in magnitude after the fixed effects are included. Clustering standard errors does not make a big difference either.

3.2 "Portfolio" Analysis

It is standard in the finance literature to work with portfolios of stocks rather than with individual stocks.[15] This can reduce measurement error in estimated risk measures such as beta, and at the same time, it is a good way to summarize the stylized facts in the data. In a similar way we form groups of countries to explore the basic empirical facts behind our regression results. For convenience we keep the term portfolio to refer to these different groups. In this section we work with growth forecasts at 5-year intervals.

We form beta portfolios in the following way. Every year $t = \{1960, 1965, ..., 1995\}$ we sort countries into five bins according to the quintile breakpoints of the distribution of betas. This sort is repeated every t, and, therefore, a country can move from one portfolio to another over time, depending on how its beta changes.[16] We compute the portfolio average as the

[15] See Cochrane (2001), ch. 20, for a survey of empirical tests of the CAPM and related models.

[16] See the appendix for the estimated transition matrix of beta and idiosyncratic volatility portfolios.

equally-weighted average of country observations assigned to each portfolio. We compute the average of consumption growth (in the 5-year interval that follows each t), the average beta, and average idiosyncratic volatility for each portfolio. We repeat the same procedure to obtain idiosyncratic volatility portfolios and portfolios based on a different number of breakpoints.

The top panel of table III summarizes the characteristics of the five beta portfolios. Consumption growth increases steadily from portfolio 1 (lowest betas) to portfolio 4. There is a decline in growth when going from portfolio 4 to 5 (highest betas). However, the spread in growth between portfolios 1 and 5 is still sizeable (45 basis points).

Figure 4 plots average consumption growth and average beta for these five portfolios along with an OLS line of the corresponding relationship. This can be considered as an empirical counterpart to equation (20) that considers the case of complete markets (noting that $k_j^* = \beta_j$). We also plot the line that goes through the world portfolio (which by definition has a beta of 1) and the intercept of the previously estimated OLS line (the zero-beta portfolio). This second line is a benchmark for the risk-growth trade-off.[17]

The estimated relationship is flatter than the proposed benchmark. According to equation (20) and assuming $\psi = 1$, the slope of the benchmark line implies a premium on the world portfolio of 0.30%, while the OLS line implies a premium of only 0.08%. The difference in slopes could be explained by attenuation bias if betas are measured with error. For instance, it is clear that portfolios with extreme betas, which is potentially a sign of measurement error, are those that are farther away from the benchmark line. Another possibility, as we emphasize throughout the paper, is that markets are incomplete and therefore there are additional factors beyond beta that contribute to the cross-section of consumption growth

[17] In the CAPM the line that relates average returns with betas is called the Security Market Line (SML). It is standard to contrast the SML estimated from the data with a theoretical SML that prices exactly the market (beta equal to 1) and the risk-free rate (beta equal to 0, or the intercept of the line). In our application the intercept is the first term in equation (20), which includes the world interest rate, but also preference parameters. Since preferences are not observable, the intercept of the theoretical line cannot be determined purely from looking at the data. For this reason we take the zero-beta portfolio growth from the estimated OLS, which amounts to comparing only the slopes of the two lines.

rates (as in equation (27)). These other factors need to be controlled for to obtain the true relationship between beta and growth.

An indication of the presence of more factors is seen in the bottom panel of table III where we sort portfolios by idiosyncratic volatility. While there is no pattern in betas across these portfolios, consumption growth is clearly lower in portfolios with relatively higher volatility. If volatility were just due to measurement error there should be no discernible pattern in average growth across these portfolios.

In table IV we form nine portfolios based on three groups of beta and three groups of idiosyncratic volatility. This maintains a reasonable number of observations per portfolio (above 30). Average consumption growth tends to increase with beta and decrease with idiosyncratic volatility. Idiosyncratic volatility is fairly constant across beta portfolios in the same volatility group, therefore volatility cannot explain the tendency of growth to increase with beta. Beta still varies across volatility portfolios in the same beta group. However, beta has a hard time explaining the declining pattern of growth within the medium-beta and high-beta groups. For instance, variation in beta goes in the "wrong" direction in the high-beta group: beta increases as we move from low to high volatility, but average growth decreases.

Figure 5 illustrates the strength of beta and idiosyncratic volatility as growth predictors by plotting the actual growth of the nine portfolios against the predicted growth from a regression with the two variables.[18] In a perfect model the points should align across the 45 degree line. The fit is still quite good, as indicated by an R^2 of 79%. The lower panels show the same nine portfolios connected within beta or volatility groups. The model performs worse in the medium volatility portfolios, while the rest of the points are relatively close to the 45 degree line.

So far we have shown differences in consumption growth for the average country in each portfolio, but differences are also observable across most of the distribution. Figure 6 shows

[18] The predicted growth comes from the OLS fitted values of the following regression at the level of portfolio averages: $\Delta c_p = b_0 + b_1\beta_p + b_2\sigma_p^{\varepsilon}$, where $p = 1, ..., 9$.

the fitted density and cumulative distribution of growth in high-beta and low-beta portfolios. The distribution of growth is shifted to the left in the low-beta portfolio compared to the high-beta portfolio, which indicates that low-beta countries have lower growth more than just on average. Something similar can be said about volatility portfolios. High-volatility countries have a higher incidence of lower growth than low-volatility countries, and this difference is not only seen for the mean of the distribution.[19]

A related concern is whether the spread in growth produced by beta and volatility is coming from a particular episode in recent history. Figure 7 shows the spread between high-beta (volatility) and low-beta (volatility) portfolios at 5-year intervals. The gray areas are periods when the spread is positive (negative) in beta (volatility) portfolios. The spread, although varying in magnitude, is positive (negative) as expected over most of our sample (1965-1990). In the early and later part of the sample we observe some small reversals. In any case, it is clear that the numbers in the tables are not driven by one particular period.

As a final example, we present in figure 8 the experience of two countries—Argentina and the U.S. This figure shows the time series of beta and growth for each country. For each year t, beta is computed with a backward looking window of 10 years, and average consumption growth with a forward-looking window of 5 years. For example, beta for 1970 is computed with data for 1961–1970 and consumption growth from 1971–1975. Consumption growth is reported relative to the world's growth. The lines for beta and relative growth should coincide if there is no measurement error and if markets are complete.[20] While the fit is not perfect, both beta and growth tend to move together. For example, the U.S. beta increases in 1980 up to almost 2, and, at the same time, U.S. growth is close to 50% higher than world growth. When beta comes down in 1985 and 1990, so does growth. In the case of Argentina, beta and growth move closely together until 1980. For example, the low beta of 1980—a

[19] Another way to put this is that the difference in means across portfolios is not due to skewness in the distributions.

[20] Strictly speaking, both lines should "almost" coincide since the intercept in equation (20) is small compared to the magnitude of beta. The relative growth line should be g_j/g^* where g^* is obtained from (20) by setting $k = 1$.

product of the 1970s—correctly forecasts the low growth in the first half of the 1980s. In 1985 beta predicts more rapid growth than actual growth, but in 1990 there is a perfect match between the two. Overall this evidence suggests that beta and expected growth are more than casually related.

3.3 Other Determinants of Growth

3.3.1 Conditional Convergence

Regressions like (30) have a long history in the empirical growth literature. A key variable of interest in this literature is initial income. The neoclassical growth model (Solow (1956)) predicts convergence, i.e., rich countries should grow at a slower pace. While this hypothesis is rejected by the data, previous papers show that there is *conditional* convergence (Barro (1991)). Rich countries grow at a slower pace after controlling for variables related to policy and endowments, which affect the steady state towards which the country converges. In this section we interpret control variables through the lens of the Solow model as the rest of the literature, but it is also possible to interpret them within the context of our model. For instance, one can say that income, policy variables and endowments are proxies for technological cross-country differences in non-financial income.

Table V presents evidence of conditional convergence in our sample. Initial per capita GDP is measured at time t, i.e., at the beginning of each 5-year or 10-year interval. The regressions without country fixed effects show a positive coefficient on initial GDP that is against absolute convergence. The coefficient on initial GDP becomes negative when the country fixed effects are included. Under the conditional convergence interpretation, fixed effects capture the slow-moving or permanent characteristics that differentiate the steady state to which each country is converging. Beta and volatility retain their magnitude and significance both at the 5-year and 10-year horizons.

3.3.2 Fertility, Education, and Investment Share

We can also try to measure directly the country characteristics that shift the steady state. We focus on measures of fertility, human capital (secondary school enrollment), and the investment share of GDP, which are the variables that have the most explanatory power in growth regressions (Athanasoulis and van Wincoop (2000), Ramey and Ramey (1995)). Secondary school enrollment is measured at time t, while the investment share of GDP and fertility are averaged over the period concurrent with beta. As seen in table VI, these variables are mostly absorbed by the country fixed effects given their slow-moving behavior.

When the fixed effects are excluded these variables regain explanatory power, in particular fertility and the investment share.[21] However, it is difficult to identify precisely the effect of each variable since they are highly correlated (Levine and Renelt (1992), Mankiw (1995)). Multicollinearity can be a more severe problem for variables that have measurement error, like our risk measures. It is perhaps not surprising that volatility is not significant in the regressions that include all variables at the same time (last column of table VI), because it is highly correlated with all of them. Beta, on the other hand, is still significant probably because its correlation with other country characteristics is low.

Another way to compare the explanatory power of these other variables is by predicting the consumption growth of the nine portfolios formed with beta and volatility. Figure 9.1 shows the result for each variable individually. Fertility produces the highest R^2 (49%) and the investment share the lowest R^2 (28%). The combination of these variables gives an R^2 of 63%, which is still lower than the 79% obtained with beta and volatility (figure 9.2). Clearly these other variables have some explanatory power, but they cannot completely substitute for the measures of risk.

The appendix shows regressions that include other standard co-variates in growth regres-

[21] The coefficient on initial GDP changes by about a factor of 4 when adding the country fixed effects to the regressions with other growth determinants and time fixed effects. This is consistent with previous papers in the empirical growth literature, in particular Caselli, Esquivel, and Lefort (1996), and Islam (1995) who use panel data techniques.

sions, such as government size or financial development. The message is similar to that of table VI. Beta retains its magnitude and significance if we add more variables, while volatility is more vulnerable to other variables and to excluding the country fixed effects.

4 Risk-Taking and Country Characteristics

4.1 Beta, Volatility, and Foreign Assets

According to the model, countries that invest more in foreign risky technologies enjoy higher expected consumption growth. Throughout the paper we use beta as a measure of this risk-taking position, since in the model beta corresponds to the fraction of wealth allocated to the world mutual fund. The question remains whether beta and direct measures of portfolio allocations are in fact such good correlates. To explore this relationship we use estimates of stocks of foreign assets and liabilities at the country level compiled by Lane and Milesi-Ferretti (2001). Despite the careful data construction, their measures rely on a number of auxiliary assumptions and they represent only proxies for variables in our model.[22] Nevertheless, we expect to find at least a positive correlation between beta and foreign asset positions if financial integration affects consumption growth through international risk-taking. One advantage of the asset positions in Lane and Milesi-Ferreti is that they represent *de facto* measures of financial integration. It is common in the literature to examine integration measures based on legal restrictions on the capital account, which can sometimes have little resemblance with actual flows across borders.

First, we examine the basic patterns of financial integration for the nine portfolios sorted by beta and idiosyncratic volatility. The top panel of Table VII shows that countries with

[22] For example, $\beta = 0.75$ taken literally implies that 75% of a country's *wealth* is invested in the world mutual fund of risky assets. A first obstacle in contrasting betas with Lane and Milesi-Ferretti's measures is that these are reported as fractions of GDP and not of total *wealth* of the country. Also, the distinction between risky and risk-free investments that is made in the model is not straightforward to apply to the data. A final minor point, except perhaps for the U.S., is that these measures consider only foreign investments, but are not corrected for the country's own position in the world mutual fund. If a country is big, this adjustment can be considerable.

high betas hold larger stocks of foreign assets over GDP than countries with low betas. Conversely, countries with high idiosyncratic volatility hold lower stocks of foreign assets than countries with low volatility. Patterns of foreign liabilities across portfolios are not as strong. Differences are again observable for the net external position (assets–liabilities) with the reversed sign when compared to assets. The sole exception is the high-beta-high-volatility portfolio that has an unusually high level of debt.

We prefer to focus on assets rather than the net external position, because liabilities are composed mostly of government bonds owned by foreigners (see the appendix). Assets are closer to private portfolio decisions, and therefore we consider them to be more appropriate for our study of private consumption growth. Assets exclude reserves held by central banks.

We report regressions of asset positions on beta and volatility in table VIII. These regressions do not imply causality or forecasting power, but only imply correlation. Assets and liabilities are taken at 5-year or 10-year intervals and are measured in the last year of the estimation window used for beta and volatility. We add time fixed effects to the regressions because of the upward trend in assets throughout the sample period. We do not include country fixed effects because of the slow-moving feature of these stock measures.

Regressions confirm that beta and the stock of foreign assets are positively correlated, while volatility and assets are negatively correlated. Coefficient estimates using 5-year intervals imply that a one-standard-deviation increase in beta is associated with a 3 percentage-point increase in the ratio of foreign assets to GDP. A one-standard-deviation increase in idiosyncratic volatility is associated with a 9 percentage-point decrease in the same ratio. Figure 10 shows that the spread in foreign assets between high-beta and low-beta countries is present in most time periods, and also between high-volatility and low-volatility countries.

The results with foreign liabilities and the net external position are weaker. There is a positive but insignificant correlation between beta and foreign liabilities, which may explain why the regression with the next external position also shows an insignificant coefficient for beta. The effect of volatility on the next external position comes from reducing assets rather than from increasing liabilities.

As a last step, we look at the relationship between foreign assets and expected consumption growth in table IX.[23] The regressions are analogous to those in table II, although they do not include country fixed effects. In the regression with a 5-year horizon, a one-standard-deviation increase in foreign assets predicts an increase of 25 basis points in average consumption growth. This coefficient and the coefficient at the 10-year horizon are significant at the 5% level.

Overall, this analysis confirms that a higher beta leads to higher expected consumption growth through the risk-taking opportunities provided by foreign assets. The negative relation between assets and volatility is not necessarily against or in favor of the model; it depends on the cross-country distributions of γ_j and σ_{csj} that are not specified by the model.

4.2 Beta, Volatility, and Development

This final section studies the correlation between our measures of risk and economic development (per capita GDP). Acemoglu and Zilibotti (1997) argue that the early stages of development are characterized by low risk-taking because of self-insurance motives. This section shows that low beta, or low international risk-taking, is not concentrated in underdeveloped economies; however, it is true that poor countries have clearly higher idiosyncratic volatility. The findings in Koren and Tenreyro (2007) on volatility and development are in line with our results.

In figure 11 we show the distributions of betas and idiosyncratic volatilities for rich and poor countries based on real per capita income in 1990. As can be seen in the top panel, rich countries have a slightly higher average beta than poor countries, but the dispersion of betas in poor countries is much higher than in rich countries. The bottom panel confirms the fact that poor countries are characterized by higher volatility than rich countries.

[23] Edison et al. (2002) find no effect of financial integration on growth when using the stock of liabilities, or assets plus liabilities, from Lane and Milesi-Ferretti (2001). They do not report results using assets alone like in this paper.

In table X we sort into portfolios based on risk measures and income to illustrate these differences. Higher beta countries are rewarded with higher consumption growth in the poor and rich groups; the pattern is reversed in the middle income group. The spread in portfolio betas among rich countries equals 3.1, which is narrower than the 5.6 spread observed among poor countries. In rich countries betas are more moderated on both ends of the distribution. Rich countries have lower frequency of low betas than poor countries (37 vs. 76 observations), which explains their slightly higher average beta. The frequency of high betas is about the same in rich and poor countries.

Table X shows that idiosyncratic volatility clearly decreases as countries become more developed. A majority of rich countries are in the low volatility group, while the opposite is true for poor countries. This implies that it may be hard to disentangle the effects of volatility and income, or other variables highly correlated with income such as fertility or education levels, as seen in the regressions in table VI. This concern does not apply to beta since beta and income are not highly correlated.

The focus of the volatility-development literature has been to explain the negative correlation between volatility and income levels (not growth rates). Most models argue that the diversification of the domestic productive structure (or lack thereof) connects volatility and the different stages of development. Our paper, on the other hand, is focused on international diversification and risk-taking. In theory, international and domestic risk-taking can be complements or substitutes depending on the covariance structure of international and domestic shocks. A full account of both domestic and international diversification is something that we do not attempt in this paper, but it certainly deserves more study.

5 Conclusions

This paper shows that the correlation between international risk-taking and expected consumption growth is strong and positive in cross-country data. We focus on a country's beta as the measure of risk-taking, because theory predicts that this is the type of risk that markets reward. Beta is also positively correlated with the foreign asset position of a country as measured by Lane and Milesi-Ferretti (2001). These findings confirm that financial integration can produce significant growth benefits by allowing investors to increase their international risk-taking, a channel that was first suggested by Obstfeld (1994a). Overall, these results favor a positive outlook on financial integration as an engine for growth and are in line with the recent evidence presented by Bekaert, Harvey, and Lundblad (2005).

Like Ramey and Ramey (1995) and Kose, Prasad, and Terrones (2006), we find a negative correlation between volatility and growth. We argue that when markets are incomplete this can happen because volatility includes the response of consumption to shocks that are not rewarded by markets (unhedgeable shocks). However, the model is not specific in terms of understanding why the combination of parameters that leads to a negative correlation between volatility and growth is so prevalent in the data. More research is necessary to understand this connection. Aghion et al. (2005) emphasize the role of credit constraints in linking high volatility and low growth. We find that more volatile countries are highly leveraged, which also suggests an explanation along these lines. Perhaps countries borrow to smooth periods of high volatility and the leveraged position in which they end up constraints borrowing for future growth.

6 Appendix

This appendix presents several robustness checks and supplementary data.

- Regions

We test the relationship between beta, idiosyncratic volatility and expected consumption growth at the level of regions motivated by papers that use geographically-defined groups to examine risk-sharing (e.g. Obstfeld (1994a)). We assign countries to five regions—Africa, Asia, Latin America, Middle East, and OECD (except Asian countries)—and run the regression of regional average 5-year future consumption growth on regional average beta and idiosyncratic volatility. Figure A1 plots the actual consumption growth by region versus the predicted. The R^2 of 67% suggests that the fit of the model is quite strong. Asian and OECD countries lie very close to the 45 degree line; only African countries are further away from it.

- Consumption Data without PPP Adjustment

We use country-level and world consumption growth from WDI to show that our results survive even after stripping off the effect of cross-country differences in price levels. Table AI reports the results of country- and time-fixed effects regressions with 5-year and 10-year forecasting horizons. The coefficient on beta doubles compared to the PWT dataset and it is significant at the 1% level. Idiosyncratic volatility, however, loses its significance. Figure A2 confirms that the spread in consumption growth between high and low beta countries is always positive while the spread between high and low idiosyncratic volatility countries is negative in all but one period.

- Beta and Volatility Measurement

This section summarizes alternative measures of beta and volatilities and their power to predict consumption growth (Table AII). The main issue when estimating beta is to define the estimation window. In the main text we use a 10-year window; here we show results with 5-year and 15-year windows. The average beta obtained using the three different windows is very similar, ranging between 0.72 and 0.86. However, the standard deviation drops from 4.6 for the 5-year window to 1.9 for the 15-year window beta. The coefficient on beta in our basic regression is between 2 and 5 basis points for the 5-year beta and between 20 and 28 basis points for the 15-year beta.

Risk-sharing papers sometimes test the response of domestic consumption growth to world GDP growth rather than to world consumption growth (e.g., Obstfeld (1994b)). Here we present results with betas on world GDP growth. The effect of world GDP beta on consumption is slightly higher as it ranges from 16 to 21 basis points. It is significant at the 5% level at both horizons.

Motivated by the finance literature (e.g., Fama and French (1992)) we also run regressions where instead of the country beta we use the average beta of the portfolio to which the country belongs to in year t. We use average betas and idiosyncratic volatilities from 9 portfolios (3x3 sort) and 25 portfolios (5x5 sort) based on these two variables. The average betas and volatilities for 9 portfolios are those reported in table IV. In the regression with the 5-year horizon, coefficients on both beta and idiosyncratic volatility are preserved (although the statistical significance is reduced). This leads us to believe that the main estimates in the paper are not driven by outliers.

- Additional Growth Determinants

In this section we test the robustness of our risk measures against a set of additional growth determinants. To the independent variables in our panel regression, we add 10-year averages (concurrent with beta) of government expenditure as a share of GDP (PWT mnemonic `kg`), openness to trade (PWT mnemonic `openk`), inflation measured as the change in GDP deflator (WDI), private bank credit over GDP (Beck, Demirgüç-Kunt and Levine (2000)) and a democracy indicator (Jaggers and Marshall (2003)). We report results for 5-year forecasting horizon (Table AIII). Beta preserves its significance in all but one of the regressions and also its coefficient remains at a level similar to the previous analysis. While idiosyncratic volatility enters with a similar coefficient and mostly significantly in the country and time fixed effects regressions, its power diminishes in the regressions without country fixed effects. Of the additional growth determinants, only government expenditure as a share of GDP and inflation are significant when both time and country fixed effects are included. Openness to trade and private credit show higher predictive power in the regressions without country fixed effects.

- Public Versus Private External Debt

Table AIV makes the distinction between private and public external debt. Whereas private debt averages at only about 3%–4% of GDP, public debt ranges between 20%–70% of GDP. The fact that private debt corresponds to only a tiny proportion of total debt may explain why our regressions with foreign liabilities do not work as well as those with foreign assets. These data are taken from the WDI. The sample covers 47 countries in 1970–2000, although the time series is shorter for some countries.

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Table I
Descriptive Statistics for Consumption Growth, Measures of Risk, Common Predictors of Consumption Growth and Measures of Financial Integration

The sample covers 74 countries from 1960 to 2000 (the years 1950-1959 are used only for the estimation of risk measures). Consumption is computed as a product of real per capita GDP in constant laspeyres prices (PWT mnemonic: *rgdpl*) and consumption share of *rgdpl* (PWT mnemonic: *kc*). Consumption growth is computed as a simple growth rate. Annualized consumption growth rates over non-overlapping 3-, 5-, and 10-year intervals are also reported. The rest of the variables are summarized in reference to the sample with 5-year intervals of consumption growth. World consumption growth is calculated as a total-consumption-weighted average of national per capita consumption growth rates. Beta is the regression coefficient of a country's consumption growth on world consumption growth using a backwards 10-year moving window (years t-9 to t). Idiosyncratic volatility is defined as the standard deviation of residuals from that regression. World consumption growth volatility is the standard deviation of world consumption growth using a backwards 10-year moving window. The correlation reported is between a country's consumption growth and world consumption growth, measured concurrently with beta. Log GDP is the log of *rgdpl* taken at time t. Investment/GDP is the investment share of *rgdpl* (PWT mnemonic: *ki*). Fertility is taken from World Development Indicators. Investment/GDP and log of fertility are averaged over the period t-9 to t. Secondary school enrollment, from Barro and Lee (2001), is measured in year t. Measures of the net external position and the stocks of foreign assets and liabilities relative to GDP are taken from Lane and Milesi-Ferretti (2001) at time t.

Variable	Obs	Mean	Std. Dev.	Min	Max
Annual Consumption Growth (%)	2721	2.22	6.35	-35.19	41.92
3-year Average Consumption Growth (%)	869	2.23	3.80	-13.78	19.22
5-year Average Consumption Growth (%)	535	2.20	2.98	-11.88	12.49
10-year Average Consumption Growth (%)	258	2.19	2.20	-6.80	8.68
World Consumption Growth (%)	535	2.45	0.72	0.98	3.18
Beta	535	0.75	2.55	-8.96	17.89
Idiosyncratic Volatility (%)	535	4.78	3.46	0.55	20.16
World Consumption Growth Volatility (%)	535	0.97	0.13	0.73	1.15
Correlation	535	0.18	0.36	-0.75	0.93
Log GDP	535	8.56	0.93	6.46	10.45
10-yr Average Investment/GDP (%)	535	18.28	8.40	1.93	56.29
10-yr Average Log Fertility	535	1.32	0.52	0.24	2.09
Secondary School Enrollment	494	22.23	15.36	0.80	69.60
Net External Position (% GDP)	408	-32.28	53.64	-654.60	204.09
Foreign Assets (%GDP)	408	36.79	68.35	1.56	833.51
Foreign Liabilities (%GDP)	408	69.07	69.06	0.55	694.07

Table II
The Effect of Beta and Idiosyncratic Volatility on Consumption Growth: Basic Regression

This table shows results for the panel regression in equation (19) in the text. The dependent variable is consumption growth over forward 1-, 3-, 5- or 10-year non-overlapping intervals. The independent variables are beta and idiosyncratic volatility, both measured from year t-9 to t. The sample period is 1961-2000 and it covers 74 countries. Time fixed effects (FE) are included in all regressions. Standard errors are reported in parentheses. Significance: * 10%, ** 5%. *** 1%.

	1-year horizon			3-year horizon			5-year horizon			10-year horizon		
	time FE, robust standard errors											
Beta	0.03		0.04	0.07		0.08	0.11 *		0.12 **	0.08		0.10 *
	(0.08)		(0.07)	(0.06)		(0.06)	(0.06)		(0.06)	(0.05)		(0.06)
Idiosyncratic		-0.10 **	-0.11 **		-0.14 ***	-0.14 ***		-0.11 **	-0.12 ***		-0.08 *	-0.10 **
Volatility		(0.05)	(0.05)		(0.05)	(0.05)		(0.05)	(0.04)		(0.05)	(0.04)
R^2	4%	4%	4%	6%	7%	8%	10%	10%	11%	11%	12%	13%
	time FE, robust standard errors clustered by country											
Beta	0.03		0.04	0.07		0.08	0.11 *		0.12 **	0.08		0.10 *
	(0.07)		(0.07)	(0.06)		(0.07)	(0.06)		(0.06)	(0.05)		(0.06)
Idiosyncratic		-0.10 **	-0.11 **		-0.14 ***	-0.14 ***		-0.11 **	-0.12 ***		-0.08 *	-0.10 **
Volatility		(0.05)	(0.05)		(0.05)	(0.05)		(0.05)	(0.04)		(0.04)	(0.04)
R^2	4%	4%	4%	6%	7%	8%	10%	10%	11%	11%	12%	13%
	time and country FE, robust standard errors											
Beta	0.04		0.05	0.12 *		0.14 *	0.14 **		0.16 **	0.10 *		0.12 **
	(0.08)		(0.08)	(0.07)		(0.07)	(0.06)		(0.07)	(0.06)		(0.06)
Idiosyncratic		-0.09	-0.10		-0.15 **	-0.16 **		-0.11 *	-0.14 **		-0.09	-0.12 *
Volatility		(0.07)	(0.07)		(0.07)	(0.07)		(0.06)	(0.06)		(0.07)	(0.07)
R^2	8%	8%	8%	20%	20%	20%	30%	30%	31%	48%	47%	49%
	time and country FE, robust standard errors clustered by country											
Beta	0.04		0.05	0.12		0.14 *	0.14 **		0.16 **	0.10 *		0.12 **
	(0.07)		(0.07)	(0.07)		(0.08)	(0.07)		(0.07)	(0.06)		(0.06)
Idiosyncratic		-0.09	-0.10		-0.15 **	-0.16 ***		-0.11 *	-0.14 **		-0.09	-0.12 *
Volatility		(0.06)	(0.06)		(0.06)	(0.06)		(0.06)	(0.05)		(0.07)	(0.07)
R^2	8%	8%	8%	20%	20%	20%	30%	30%	31%	48%	47%	49%
# Observations	2721	2721	2721	869	869	869	535	535	535	258	258	258

Table III
Averages of Consumption Growth, Beta and Idiosyncratic Volatility across Portfolios Sorted by Beta (Top Panel) and Idiosyncratic Volatility (Bottom Panel)

Each year t = {1960, 1965, 1970,…, 1995}, countries are assigned to one of five portfolios based on quintile breakpoints for the distribution of betas (idiosyncratic volatilities). Breakpoints are computed every year t from the cross-section of betas (idiosyncratic volatilities). For each portfolio, we compute the mean of consumption growth over 5-year non-overlapping intervals t+1 to t+5 (specifically, 1961-1965, 1966-1970,…, 1996-2000); and means of beta, idiosyncratic volatility, and total volatility all measured from year t-9 to t.

	Consumption Growth (%)	Beta	Idiosyncratic Volatility (%)	Total Volatility (%)
	Beta Portfolios			
Low	1.70	-2.38	6.28	6.80
2	2.22	-0.04	3.45	3.49
3	2.45	0.72	3.62	3.73
4	2.48	1.53	3.90	4.26
High	2.15	3.92	6.65	7.81
	Idiosyncratic Volatility Portfolios			
Low	2.37	0.68	1.38	1.68
2	2.69	0.68	2.47	2.79
3	2.58	0.64	3.94	4.34
4	1.88	1.08	5.88	6.42
High	1.47	0.67	10.30	10.94

Table IV
Averages of Consumption Growth, Beta and Idiosyncratic Volatility across Portfolios Sorted by Beta and Idiosyncratic Volatility

Each year t = {1960, 1965, 1970,…, 1995}, countries are assigned to one of three portfolios based on tercile breakpoints of the distribution of betas (idiosyncratic volatilities). Tercile breakpoints are obtained separately (i.e. not one within the other) from the cross-section of betas and idiosyncratic volatilities every year t. For each portfolio, we compute the mean of consumption growth over 5-year non-overlapping intervals t+1 to t+5 (specifically, 1961-1965, 1966-1970,…, 1996-2000); and means of beta and idiosyncratic volatility, both measured from year t-9 to t. The number of observations in each portfolio is also reported.

	Idiosyncratic Volatility Portfolios		
	Low	Medium	High
Beta Portfolios	Consumption Growth (%)		
Low	2.15	2.44	1.24
Medium	2.63	2.56	1.70
High	2.66	2.22	2.12
	Beta		
Low	-0.44	-1.18	-2.64
Medium	0.68	0.76	0.73
High	1.87	2.68	3.89
	Idiosyncratic Volatility (%)		
Low	1.81	3.83	8.68
Medium	1.65	3.91	8.09
High	1.83	4.05	8.73
	# Observations		
Low	49	59	68
Medium	84	57	36
High	45	59	78

Table V
The Effect of Beta and Idiosyncratic Volatility on Consumption Growth: Accounting for Conditional Convergence

This table shows results for the panel regression in equation (19) in the text. The dependent variable is consumption growth over forward 5- or 10-year non-overlapping intervals. The independent variables are beta and idiosyncratic volatility, both measured from year t-9 to t, and the log of GDP measured in year t. The sample period is 1961-2000 and it covers 74 countries. Time fixed effects (FE) are included in all regressions. Standard errors are reported in parentheses. Significance: * 10%, ** 5%. *** 1%.

	5-year horizon		10-year horizon	
	time FE, robust standard errors			
Beta	0.11	*	0.08	
	(0.06)		(0.06)	
Idiosyncratic Volatility	-0.08	*	-0.06	
	(0.05)		(0.04)	
Log GDP	0.33	**	0.29	*
	(0.14)		(0.15)	
R^2	12%		14%	
	time FE, robust standard errors clustered by country			
Beta	0.11	*	0.08	
	(0.06)		(0.06)	
Idiosyncratic Volatility	-0.08	*	-0.06	
	(0.05)		(0.04)	
Log GDP	0.33	*	0.29	*
	(0.17)		(0.17)	
R^2	12%		14%	
	time and country FE, robust standard errors			
Beta	0.14	**	0.11	*
	(0.07)		(0.06)	
Idiosyncratic Volatility	-0.16	***	-0.14	**
	(0.06)		(0.07)	
Log GDP	-2.81	***	-2.98	***
	(0.73)		(0.84)	
R^2	34%		54%	
	time and country FE robust standard errors clustered by country			
Beta	0.14	**	0.11	*
	(0.06)		(0.06)	
Idiosyncratic Volatility	-0.16	***	-0.14	**
	(0.05)		(0.06)	
Log GDP	-2.81	***	-2.98	***
	(0.77)		(0.84)	
R^2	34%		54%	
# Observations	535		258	

Table VI
The Effect of Beta and Idiosyncratic Volatility on Consumption Growth: Other Determinants of Growth

This table shows results for the panel regression in equation (19) in the text. The dependent variable is consumption growth over forward 5- or 10-year non-overlapping intervals. The independent variables are beta and idiosyncratic volatility, both measured from year t-9 to t; the log of GDP measured in year t; investment as a share of GDP and the log of fertility rates averaged over the period t-9 to t; and secondary school enrollment measured at t. The sample period is 1961-2000 and it covers 74 countries, except for the regressions with secondary school enrollment. Time fixed effects (FE) are included in all regressions. Robust standard errors clustered by country are reported in parentheses. Significance: * 10%, ** 5%. *** 1%.

	5-year horizon							
	time and country FE robust standard errors clustered by country						without country FE	
Beta	0.14 **	0.16 **	0.17 **	0.19 ***		0.17 ***		0.13 **
	(0.06)	(0.07)	(0.07)	(0.07)		(0.06)		(0.06)
Idiosyn. Volatility	-0.16 ***	-0.14 **	-0.13 **	-0.12 **		-0.14 **		-0.05
	(0.05)	(0.06)	(0.06)	(0.06)		(0.06)		(0.05)
Log GDP	-2.81 ***				-3.50 ***	-3.51 ***	-0.76 **	-0.82 **
	(0.77)				(1.12)	(1.08)	(0.37)	(0.37)
Investment/GDP		0.01			0.02	0.03	0.05 *	0.05 **
		(0.04)			(0.06)	(0.05)	(0.03)	(0.02)
Log Fertility			-0.63		-2.12 *	-1.72	-2.40 ***	-2.20 ***
			(0.97)		(1.12)	(1.09)	(0.52)	(0.54)
Secondary School Enrollment				-0.01	-0.01	0.01	-0.01	-0.01
				(0.02)	(0.02)	(0.02)	(0.01)	(0.01)
R^2	34%	31%	30%	31%	32%	35%	16%	17%
# Observations	535	535	535	494	494	494	494	494
# Countries	74	74	74	69	69	69	69	69

	10-year horizon							
	time and country FE robust standard errors clustered by country						without country FE	
Beta	0.11 *	0.12 *	0.12 **	0.13 **		0.13 **		0.10 *
	(0.06)	(0.07)	(0.06)	(0.06)		(0.06)		(0.06)
Idiosyn. Volatility	-0.14 **	-0.12 *	-0.12 *	-0.11		-0.16 **		-3.75
	(0.06)	(0.07)	(0.07)	(0.07)		(0.07)		(4.27)
Log GDP	-2.98 ***				-3.24 ***	-3.51 ***	-0.86 **	-0.93 ***
	(0.84)				(1.24)	(1.16)	(0.35)	(0.35)
Investment/GDP		0.00			0.03	0.06	0.05 **	0.06 **
		(0.06)			(0.07)	(0.07)	(0.03)	(0.03)
Log Fertility			-0.03		0.02	0.13	-0.60 ***	-0.56 ***
			(0.30)		(0.27)	(0.26)	(0.14)	(0.14)
Secondary School Enrollment				-0.01	0.01	0.02	0.00	0.00
				(0.02)	(0.02)	(0.02)	(0.01)	(0.01)
R^2	54%	49%	49%	48%	51%	54%	23%	25%
# Observations	258	258	258	238	238	238	238	238
# Countries	74	74	74	69	69	69	69	69

Table VII

Averages of Financial Integration Measures Across Portfolios Sorted by Beta and Idiosyncratic Volatility

Each year t = {1970, 1975,…,1995}, countries are assigned to one of three portfolios based on tercile breakpoints of the distribution of betas (idiosyncratic volatilities). Tercile breakpoints are obtained separately (i.e. not one within the other) from the cross-section of betas and idiosyncratic volatilities every year t. For each portfolio, we compute the mean of foreign assets/GDP, foreign liabilities/GDP, and net external position (assets-liabilities) measured in year t.

	Idiosyncratic Volatility Portfolios		
	Low	Medium	High
Beta Portfolios	Foreign Assets (% GDP)		
Low	33	10	17
Medium	55	32	17
High	44	28	21
	Foreign Liabilities (% GDP)		
Low	68	62	63
Medium	69	69	58
High	63	64	93
	Net External Position (% GDP)		
Low	-28	-45	-38
Medium	-7	-29	-36
High	-11	-30	-64

Table VIII

Relationship between Beta, Idiosyncratic Volatility and Financial Integration

The dependent variable is one of three measures from Lane and Milesi-Ferretti (2001): (1) foreign assets/GDP, or (2) foreign liabilities/GDP, (3) net external position (assets-liabilities)/GDP. These are measured in year t={1970, 1975,…,1995) in the regression at 5-year intervals. Beta and idiosyncratic volatility, measured from t-9 to t, are the independent variables. The sample period is 1970-1995 and it covers data for 72 countries. All regressions include time fixed effects. Robust standard errors clustered by country are reported in parentheses. Significance: * 10%, ** 5%. *** 1%.

	5-year intervals		10-year intervals	
	Foreign Assets (% GDP)			
Beta	1.12	**	1.45	**
	(0.48)		(0.64)	
Idiosyncratic Volatility	-2.69	**	-2.61	**
	(1.21)		(1.33)	
R^2	7%		7%	
	Foreign Liabilities (% GDP)			
Beta	4.05		3.84	
	(2.65)		(3.15)	
Idiosyncratic Volatility	1.93		1.54	
	(1.64)		(1.70)	
R^2	18%		16%	
	Net External Position (% GDP)			
Beta	-2.77		-2.05	
	(2.79)		(3.28)	
Idiosyncratic Volatility	-4.47	***	-3.77	**
	(1.52)		(1.60)	
R^2	17%		12%	
# Observations	408		201	

Table IX
The Effect of Financial Integration on Consumption Growth

The dependent variable is forward consumption growth at 5- or 10-year non-overlapping intervals. For the 5-year horizon, consumption growth is measured from t+1 to t+5, where t={1970, 1975,…,1995}. The independent variable is one of three measures from Lane and Milesi-Ferretti (2001): (1) foreign assets/GDP, or (2) foreign liabilities/GDP, (3) net external position (assets-liabilities)/GDP, all measured at time t. The coefficients on financial integration measures are multiplied by 10^4. The sample period is 1970-2000 and it covers data for 72 countries. All regressions include time fixed effects. Robust standard errors clustered by country are reported in parentheses. Significance: * 10%, ** 5%. *** 1%.

	5-year horizon		
Foreign Assets	0.37 ***		
	(0.14)		
Foreign Liabilities		0.03	
		(0.18)	
Net External Position			0.64 *
			(0.34)
R^2	8%	8%	9%
# Observations	408	408	408
	10-year horizon		
Foreign Assets	0.21 **		
	(0.11)		
Foreign Liabilities		-0.08	
		(0.15)	
Net External Position			0.41
			(0.31)
R^2	7%	7%	8%
# Observations	201	201	201

Table X

Averages of Consumption Growth, Beta and Idiosyncratic Volatility across Portfolios Sorted by Initial GDP and Beta (Left Panel) and Initial GDP and Idiosyncratic Volatility (Right Panel)

Each year t = {1960, 1965, 1970,…, 1995}, countries are assigned to one of three portfolios based on tercile breakpoints of the distribution of real per capita GDP (betas, idiosyncratic volatilities). Tercile breakpoints are obtained separately (i.e. not one within the other) from the cross-section of these measures every year t. For each portfolio, we compute the mean of consumption growth over 5-year non-overlapping intervals t+1 to t+5 (specifically, 1961-1965, 1966-1970,…, 1996-2000); and means of beta or idiosyncratic volatility, both measured from year t-9 to t. The number of observations in each portfolio is also reported.

	Beta Portfolios			Idiosyncratic Volatility Portfolios		
	Low	Medium	High	Low	Medium	High
GDP Portfolios	Consumption Growth (%)			Consumption Growth (%)		
Poor	1.35	2.32	1.95	1.85	2.21	1.43
Middle-Income	2.11	2.02	1.89	1.87	2.30	1.76
Rich	2.65	2.75	2.97	2.85	3.05	2.41
	Beta			Idiosyncratic Volatility (%)		
Poor	-2.16	0.69	3.50	2.06	3.99	9.15
Middle-Income	-1.34	0.70	3.01	1.83	3.96	8.37
Rich	-0.60	0.73	2.51	1.65	3.75	7.39
	# Observations			# Observations		
Poor	76	41	59	21	67	88
Middle-Income	63	56	60	41	75	63
Rich	37	80	63	116	33	31

Table AI

The Effect of Beta and Idiosyncratic Volatility on Consumption Growth: WDI Data

This table shows results for the panel regression in equation (19) in the text. The dependent variable is consumption growth over forward 5- or 10-year non-overlapping intervals, taken from WDI. The independent variables are beta and idiosyncratic volatility, both measured from year t-9 to t. The sample period is 1976-2004 and it covers 68 countries. Time- and country-fixed effects are included in all regressions. Robust standard errors clustered by country are reported in parentheses. Significance: * 10%, ** 5%. *** 1%.

	5-year horizon		10-year horizon	
Beta	0.31	***	0.26	***
	(0.09)		(0.08)	
Idiosyncratic Volatility	0.03		0.13	
	(0.09)		(0.12)	
R^2	38%		53%	
# Observations	371		179	

Table AII

The Effect of Beta and Idiosyncratic Volatility on Consumption Growth: Different Beta and Volatility Measures

This table shows results for the panel regression in equation (19) in the text. The dependent variable is consumption growth over forward 5- or 10-year non-overlapping intervals. The independent variables are beta and idiosyncratic volatility, both measured in one of the following ways: (1) from year t-4 to t; (2) from year t-14 to t; (3) on world GDP from year t-9 to t; (4) as averages of portfolio betas (idiosyncratic volatility) from year t-9 to t. The sample period is 1956-2000 for (1), 1966-2000 for (2), and 1961-2000 for (3) and (4). The number of countries in all regressions is 74. Time- and country-fixed effects are included in all regressions. Robust standard errors clustered by country are reported in parentheses. Significance: * 10%, ** 5%. *** 1%.

	5-year window	15-year window	World GDP 10-year window	3x3 Portfolio	5x5 Portfolio
			5-year horizon		
Beta	0.05 *	0.28 **	0.16 **	0.11	0.13
	(0.03)	(0.12)	(0.08)	(0.08)	(0.08)
Idiosyncratic Volatility	-0.03	-0.12	-0.10 *	-0.11	-0.15 ***
	(0.05)	(0.08)	(0.06)	(0.06)	(0.06)
R^2	31%	32%	31%	30%	31%
# Observations	609	461	535	535	535
			10-year horizon		
Beta	0.02	0.20	0.21 **	0.03	0.07
	(0.03)	(0.12)	(0.10)	(0.07)	(0.07)
Idiosyncratic Volatility	-0.14 ***	-0.07	-0.09	-0.09	-0.12 **
	(0.05)	(0.12)	(0.06)	(0.09)	(0.06)
R^2	50%	51%	49%	47%	47%
# Observations	275	201	258	258	258

Table AIII

The Effect of Beta and Idiosyncratic Volatility on Consumption Growth: Additional Determinants of Growth

This table shows results for the panel regression in equation (19) in the text. The dependent variable is consumption growth over forward 5-year non-overlapping intervals. The independent variables are beta and idiosyncratic volatility, both measured from year t-9 to t; four growth determinants discussed in section 3.3 and the averages of government expenditure as a share of GDP (PWT mnemonic: kg), openness (PWT mnemonic: openk), growth of GDP deflator (WDI), private credit (Beck et al. (2000)), and democracy indicator (Jaggers and Marshall (2003)) all measured from year t-9 to t. The sample period is 1961-2000 and it covers 58-74 countries, depending on data availability. Time fixed effects (FE) are included in all regressions. Robust standard errors clustered by country are reported in parentheses. Significance: * 10%, ** 5%. *** 1%.

	time and country FE robust standard errors clustered by country								without country FE		
Beta	0.17***	0.16**	0.13**	0.18**	0.17**		0.15*	0.13*		0.11*	0.09
	(0.07)	(0.07)	(0.06)	(0.09)	(0.07)		(0.08)	(0.07)		(0.07)	(0.07)
Idiosyn. Volatility	-0.15***	-0.14**	-0.13**	-0.11	-0.13**		-0.13	-0.13		-0.04	-0.01
	(0.05)	(0.05)	(0.07)	(0.08)	(0.06)		(0.09)	(0.09)		(0.05)	(0.06)
Gov't Expenditure	0.08**					0.08	0.09	0.07	0.04**	0.04**	0.04**
	(0.04)					(0.07)	(0.07)	(0.07)	(0.02)	(0.02)	(0.02)
Openness to Trade		0.00				0.00	0.01	0.01	-0.01**	-0.01**	-0.01
		(0.01)				(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)
Inflation x 100			0.20***			0.22***	0.19**	0.12	0.03	0.01	0.01
			(0.05)			(0.08)	(0.08)	(0.09)	(0.03)	(0.04)	(0.04)
Private Credit				-1.15		0.14	0.15	1.64	1.13**	0.98*	0.09
				(1.36)		(1.40)	(1.39)	(1.47)	(0.56)	(0.59)	(0.58)
Democracy					0.02	0.02	0.01	0.03	0.03	0.02	0.01
					(0.03)	(0.03)	(0.03)	(0.04)	(0.02)	(0.02)	(0.03)
Log GDP								-3.88*			-0.93**
								(2.06)			(0.45)
Investment/GDP								-0.02			0.06**
								(0.08)			(0.02)
Log Fertility								-1.39			-2.34***
								(1.64)			(0.60)
Secondary School Enrollment								-0.01			-0.01
								(0.02)			(0.01)
R^2	32%	31%	34%	33%	31%	34%	35%	38%	17%	18%	23%
# Observations	535	535	475	383	508	377	377	374	377	377	374
# Countries	74	74	74	58	71	58	58	58	58	58	58

Table AIV
Averages of Private and Public External Debt Across Portfolios Sorted by Beta and Idiosyncratic Volatility

Each year t = {1970, 1975,…,1995}, countries are assigned to one of three portfolios based on tercile breakpoints of the distribution of betas (idiosyncratic volatilities). Tercile breakpoints are obtained separately (i.e. not one within the other) from the cross-section of betas and idiosyncratic volatilities every year t. For each portfolio, we compute the mean of external private and public debt (from WDI) measured in year t.

	Idiosyncratic Volatility Portfolios		
	Low	Medium	High
Beta Portfolios	Private Debt (% GDP)		
Low	3	4	4
Medium	3	3	3
High	4	5	5
	Public Debt (% GDP)		
Low	52	36	34
Medium	22	34	36
High	23	38	72

Table AV
Correlation Matrix for All Independent Variables (5-year intervals)

	Beta	Idios. Volatility	Log GDP	I/GDP	Log Fertility	Sec. Sch. Enrol.	Gov't Exp/GDP	Openness	Inflation	Private Credit	Democr.	Foreign Assets	Foreign Liab.	Net Ext. Position
Beta	1.00													
Idios. Volatility	0.06	1.00												
Log GDP	0.05	-0.41	1.00											
I/GDP	-0.04	-0.29	0.68	1.00										
Log Fertility	-0.11	0.39	-0.88	-0.62	1.00									
Sec. Sch. Enrol.	0.07	-0.31	0.77	0.53	-0.77	1.00								
Gov't Ex/GDP	0.08	0.35	-0.30	-0.25	0.30	-0.20	1.00							
Openness	-0.02	0.32	-0.26	-0.14	0.24	-0.11	0.24	1.00						
Inflation	0.27	0.21	-0.12	-0.14	0.07	-0.09	0.27	-0.08	1.00					
Private Credit	0.03	-0.34	0.70	0.55	-0.68	0.67	-0.32	-0.12	-0.15	1.00				
Democracy	0.03	-0.29	0.50	0.30	-0.51	0.50	-0.12	-0.08	0.01	0.34	1.00			
Foreign Assets	0.06	-0.17	0.51	0.24	-0.52	0.47	-0.14	0.21	-0.04	0.52	0.31	1.00		
Foreign Liab.	0.28	0.16	0.04	-0.10	-0.11	0.09	0.25	0.27	0.51	0.07	0.12	0.47	1.00	
Net Ext. Position	-0.25	-0.31	0.36	0.31	-0.29	0.27	-0.39	-0.13	-0.59	0.34	0.12	0.28	-0.71	1.00

Table AVI
Transition Matrices for Beta and Idiosyncratic Volatility Portfolios (%)

	Beta Portfolios				
	1	2	3	4	5
1	46	24	10	12	9
2	19	20	27	19	15
3	17	27	22	23	11
4	8	20	29	24	20
5	10	5	16	23	46
	Idiosyncratic Volatility Porfolios				
	1	2	3	4	5
1	67	20	6	5	1
2	27	40	20	8	6
3	5	30	38	19	8
4	3	6	31	37	23
5	1	4	7	24	64

Table AVII
List of Countries

Country	Country
Argentina	Japan
Australia	Jordan
Austria	Kenya
Bangladesh	Korea
Belgium	Luxembourg
Bolivia	Malaysia
Brazil	Mexico
Cameroon	Morocco
Canada	Netherlands
Chile	New Zealand
China	Nicaragua
Colombia	Norway
Costa Rica	Pakistan
Cote d`Ivoire	Paraguay
Denmark	Peru
Dominican Republic	Philippines
Ecuador	Poland
Egypt	Portugal
El Salvador	Romania
Finland	Senegal
France	Sierra Leone
Germany	Singapore
Ghana	South Africa
Greece	Spain
Guatemala	Sri Lanka
Guinea	Sweden
Honduras	Switzerland
Hong Kong	Syria
Hungary	Thailand
Iceland	Tunisia
India	Turkey
Indonesia	United Kingdom
Iran	United States
Ireland	Uruguay
Israel	Venezuela
Italy	Zambia
Jamaica	Zimbabwe

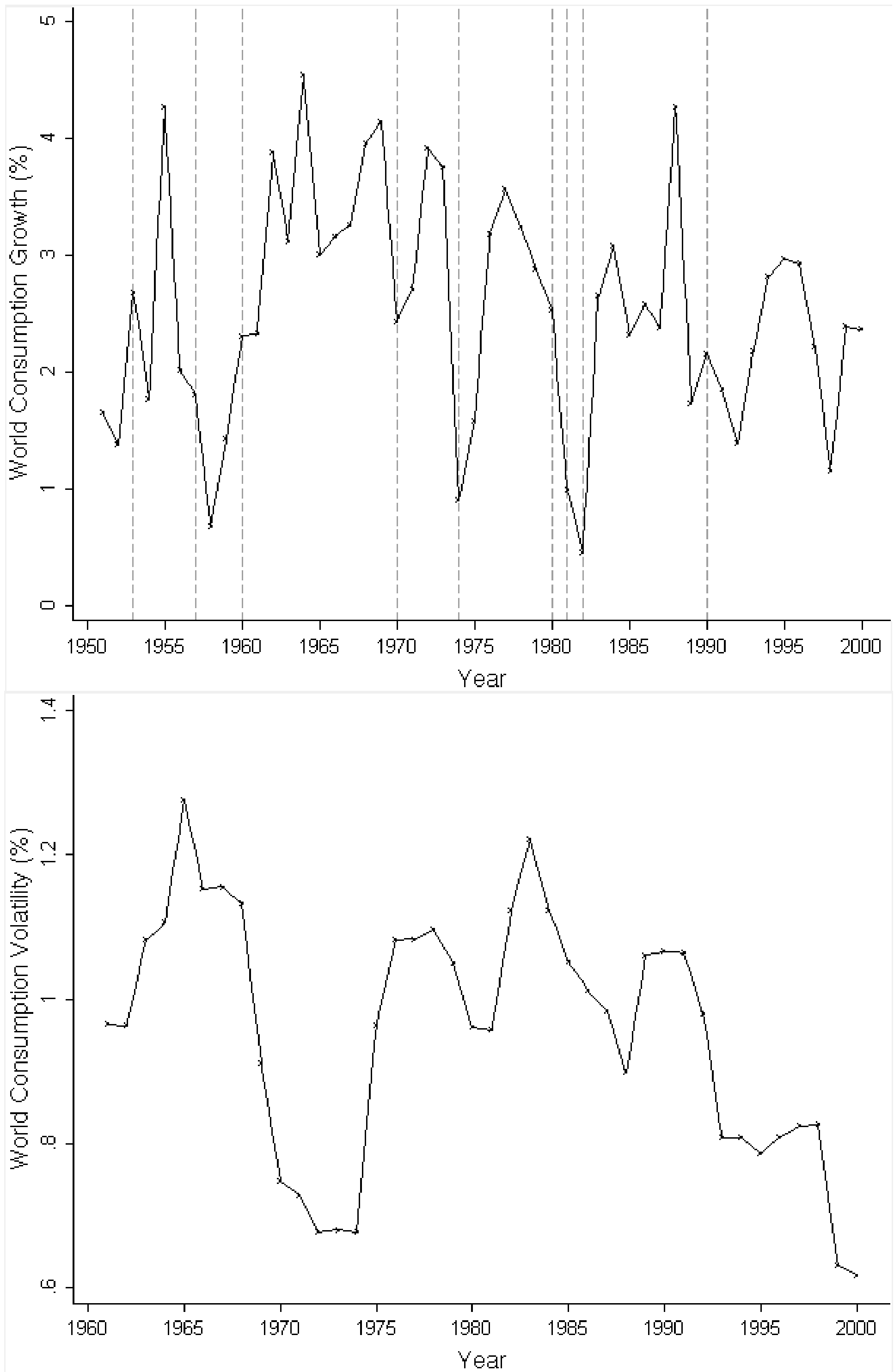

Figure 1. World Consumption Growth and World Consumption Volatility. World consumption growth is calculated as the total-consumption-weighted average of national per capita consumption growth rates. World consumption growth volatility is the standard deviation of world consumption growth computed with a backwards 10-year moving window. The dashed lines in the top figure represent NBER recessions in the U.S.

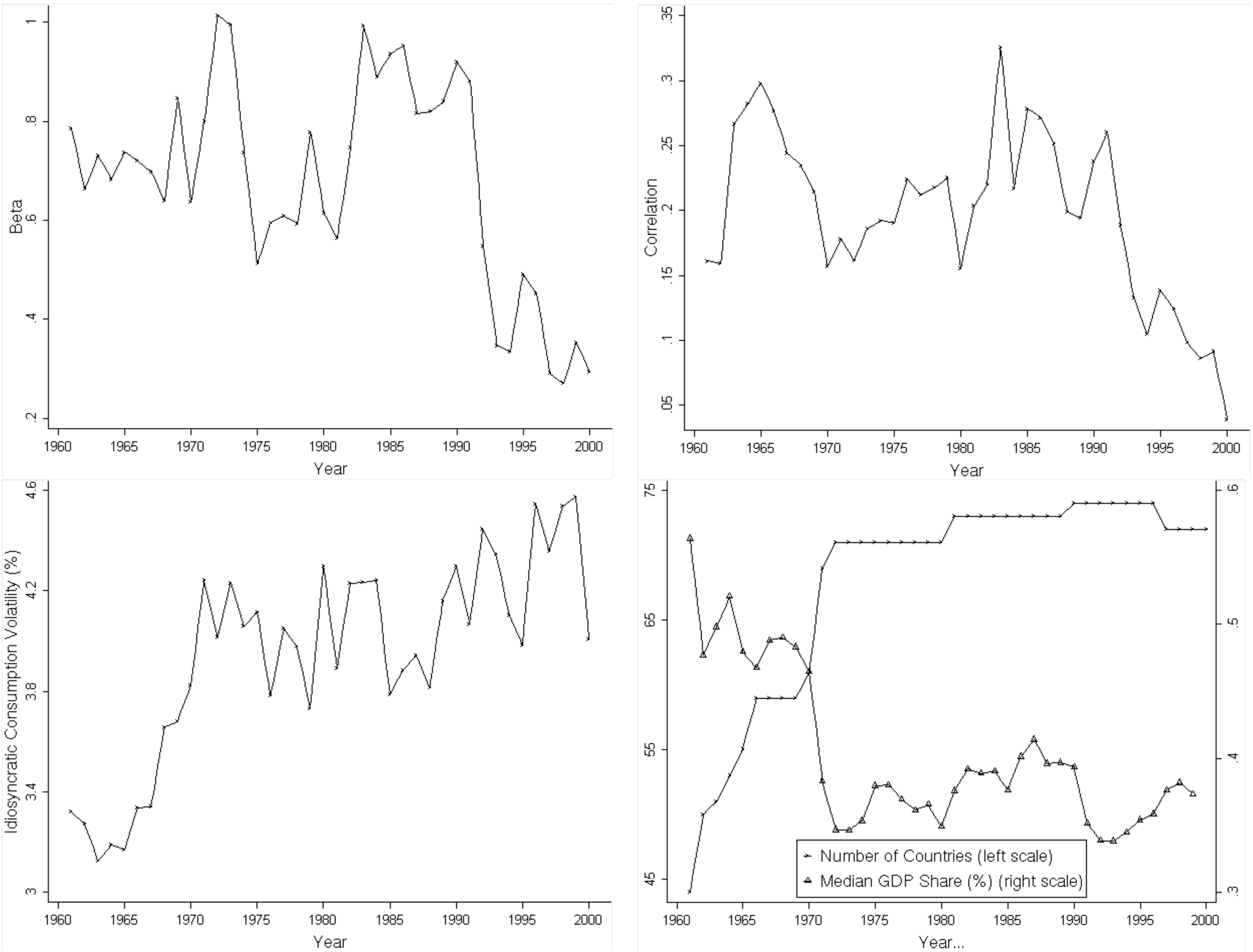

Figure 2. Median Beta, Correlation, Idiosyncratic Consumption Volatility, GDP Share and Number of Countries. Beta is the regression coefficient of a country's consumption growth on world consumption growth estimated with a backwards 10-year moving window. Idiosyncratic volatility is defined as the standard deviation of residuals from that regression. The correlation is between a country's consumption growth and world consumption growth over the same window. GDP share is total GDP of a country over world GDP. For beta, volatility, correlation and GDP share the figure shows the sample median (across countries) in each year. The number of countries corresponds to the countries in the Penn World Table each year after imposing the restrictions described in section 2.1.

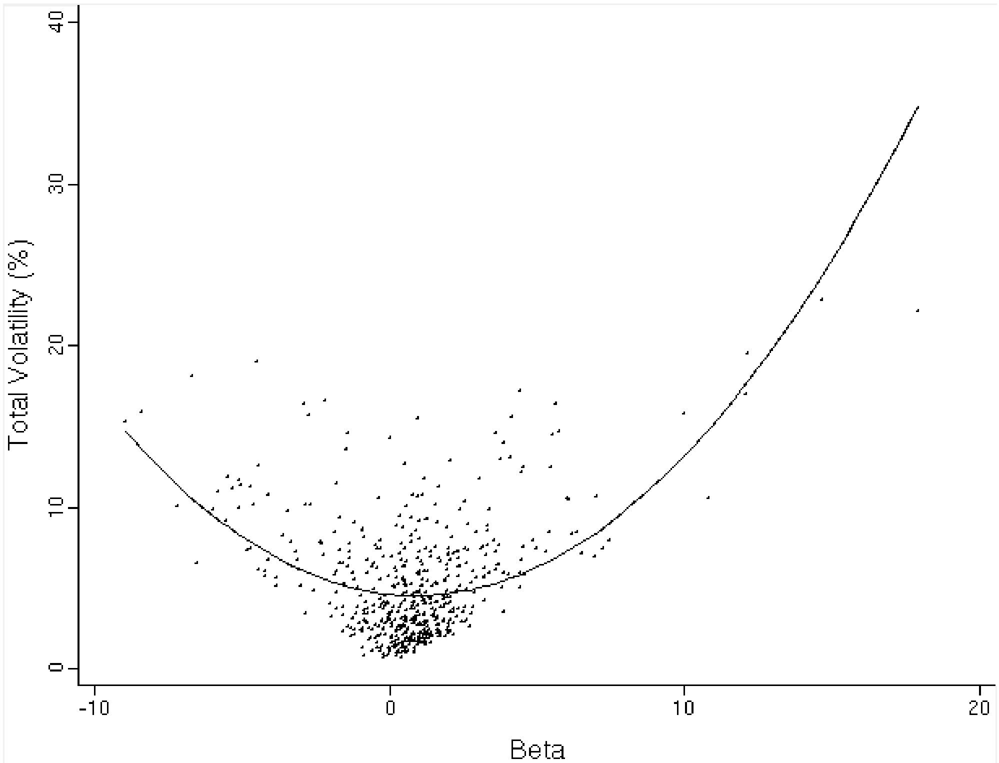

Figure 3. Beta and Total Volatility. Beta is the regression coefficient of a country's consumption growth on world consumption growth estimated with a backwards 10-year moving window. Total volatility is the standard deviation of a country's consumption growth. This figure shows betas and volatilities at 5-year intervals in our sample of 74 countries (535 observations in total). The solid line corresponds to the fitted values from a regression of volatility on beta and its quadratic term.

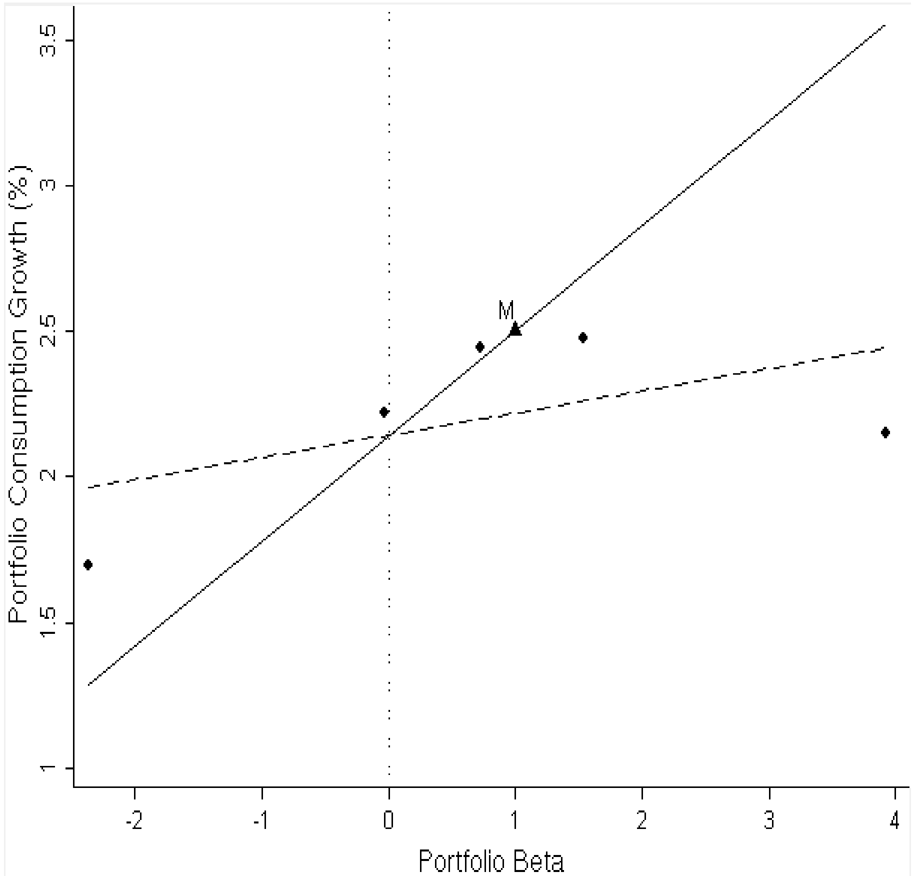

Figure 4. Consumption Growth Versus Beta for 5 Beta Portfolios. The figure shows the average beta and average consumption growth for 5 country portfolios based on beta. Every year t = {1960, 1965, 1970,…, 1995}, countries are assigned to portfolios based on quintile breakpoints that are computed that year based on the cross-section of betas. For each country we compute the consumption growth over 5-year non-overlapping intervals t+1 to t+5 (specifically, 1961-1965, 1966-1970,…, 1996-2000), and we then average over countries in each portfolio. Beta is measured from year t-9 to t. The dashed line is the fitted OLS line using the 5 portfolio observations. The point M represents the world ("market") portfolio, which by definition has a beta equal to 1. The solid line goes through point M and the zero-beta portfolio growth implied by the previous OLS line.

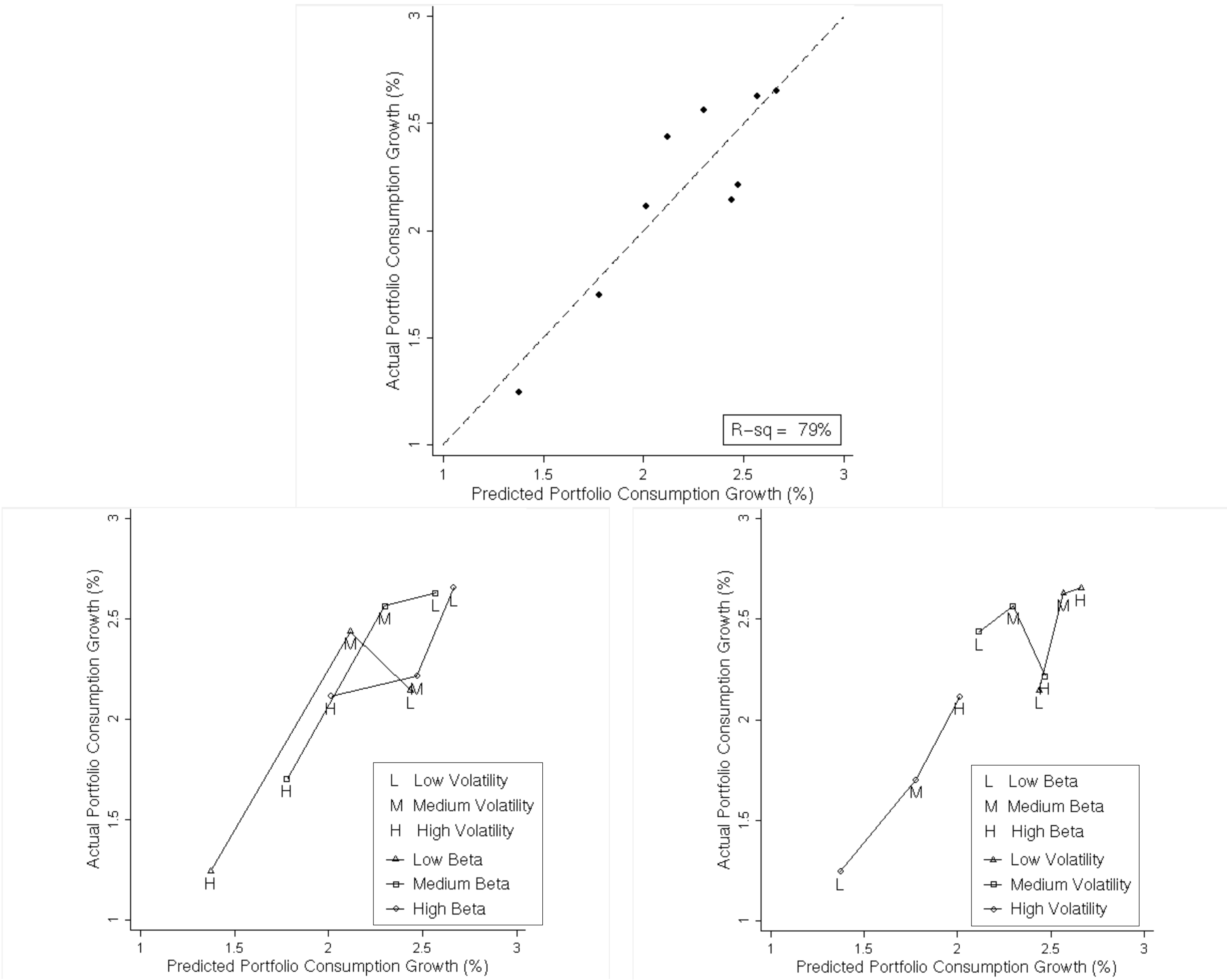

Figure 5. Actual Versus Predicted Consumption Growth for 9 Portfolios Sorted by Beta and Idiosyncratic Volatility. Predicted consumption growth is the fitted value from a regression of portfolio average consumption growth on portfolio average beta and idiosyncratic volatility using the 9 portfolio observations. In the top figure, the dashed line is the 45 degree line. R^2 of the fit is also reported. In the left (right) bottom figure, points are connected within beta (idiosyncratic volatility) portfolios and labeled as L(low)-M(median)-H(high) based on their ranking in idiosyncratic volatility (beta). Each year t = {1960, 1965, 1970, …, 1995} countries are assigned to one of nine portfolios based on how their beta and idiosyncratic volatility compare to the tercile breakpoints in the cross-section of betas and idiosyncratic volatility. In each portfolio we compute averages of the following variables: (1) consumption growth over 5-year non-overlapping intervals t+1 to t+5, (2) beta and (3) idiosyncratic volatility, both measured from year t-9 to t.

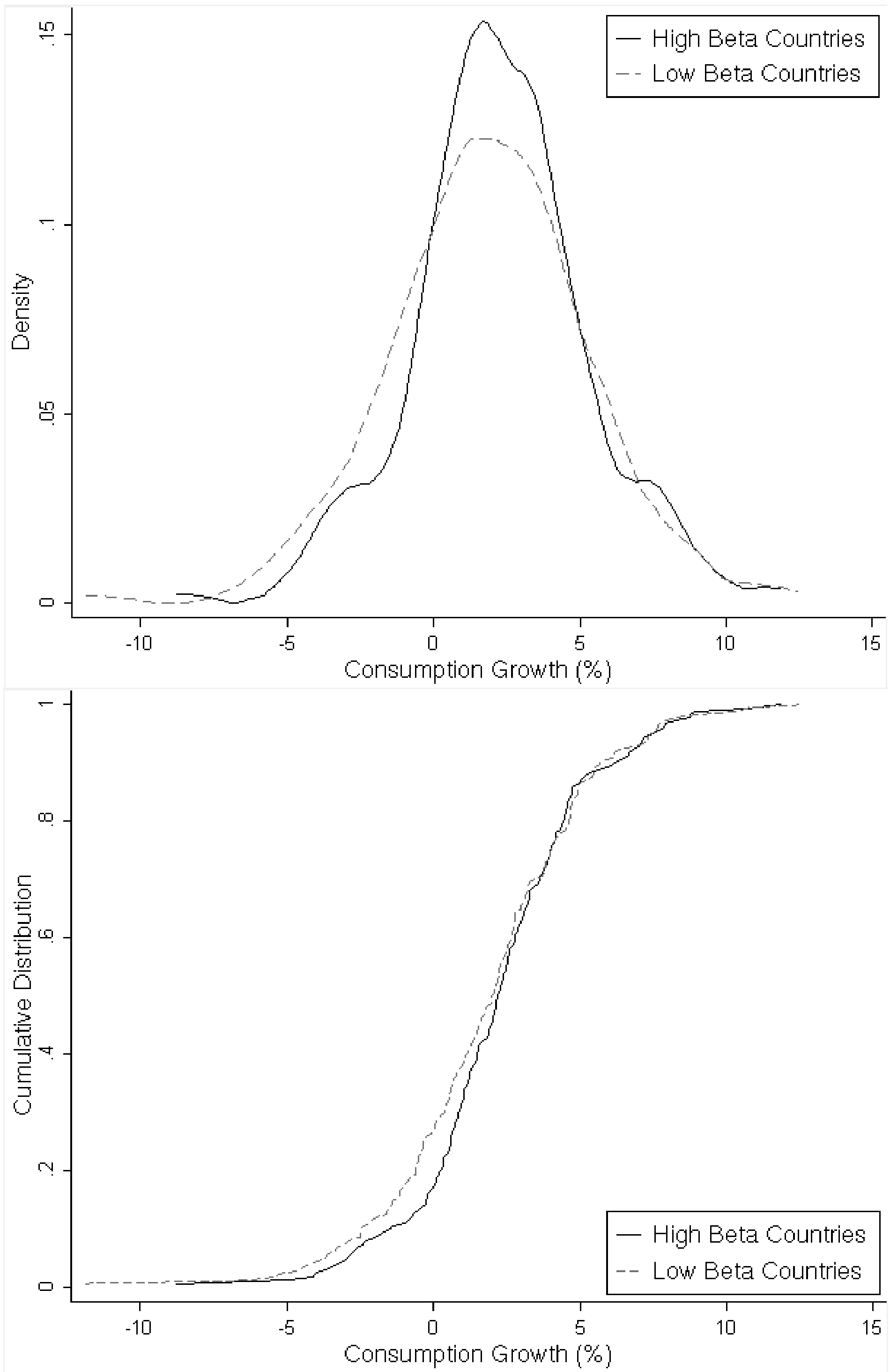

Figure 6.1. Distribution of Consumption Growth in High and Low Beta Countries. Countries are assigned to portfolios based on tercile breakpoints that are computed every year t in the cross-section of betas, where t = {1960, 1965, 1970,…, 1995}. Beta is measured from year t-9 to t. The top figure shows the fitted density function and the bottom figure shows the cumulative distribution function of consumption growth for countries in the top (3^{rd} tercile) and bottom (1^{st} tercile) portfolios formed on beta. Consumption growth is computed over 5-year non-overlapping intervals t+1 to t+5.

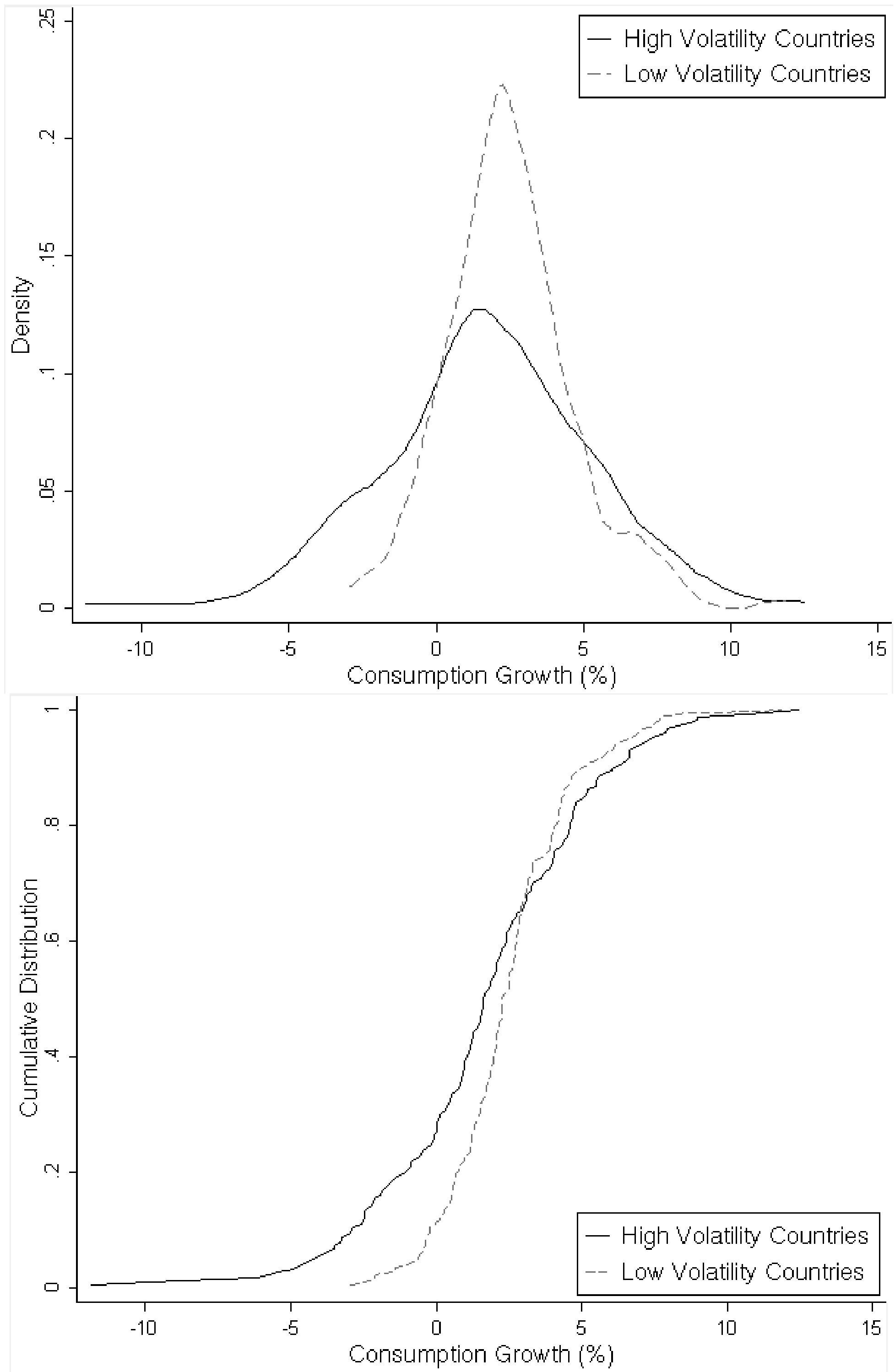

Figure 6.2. Distribution of Consumption Growth in High and Low Volatility Countries. Countries are assigned to portfolios based on tercile breakpoints that are computed every year t in the cross-section of idiosyncratic volatilities, where t = {1960, 1965, 1970,…, 1995}. Idiosyncratic volatility is measured from year t-9 to t. The top figure shows the fitted density function and the bottom figure shows the cumulative distribution function of consumption growth for countries in the top (3rd tercile) and bottom (1st tercile) portfolios formed on idiosyncratic voaltility. Consumption growth is computed over 5-year non-overlapping intervals t+1 to t+5.

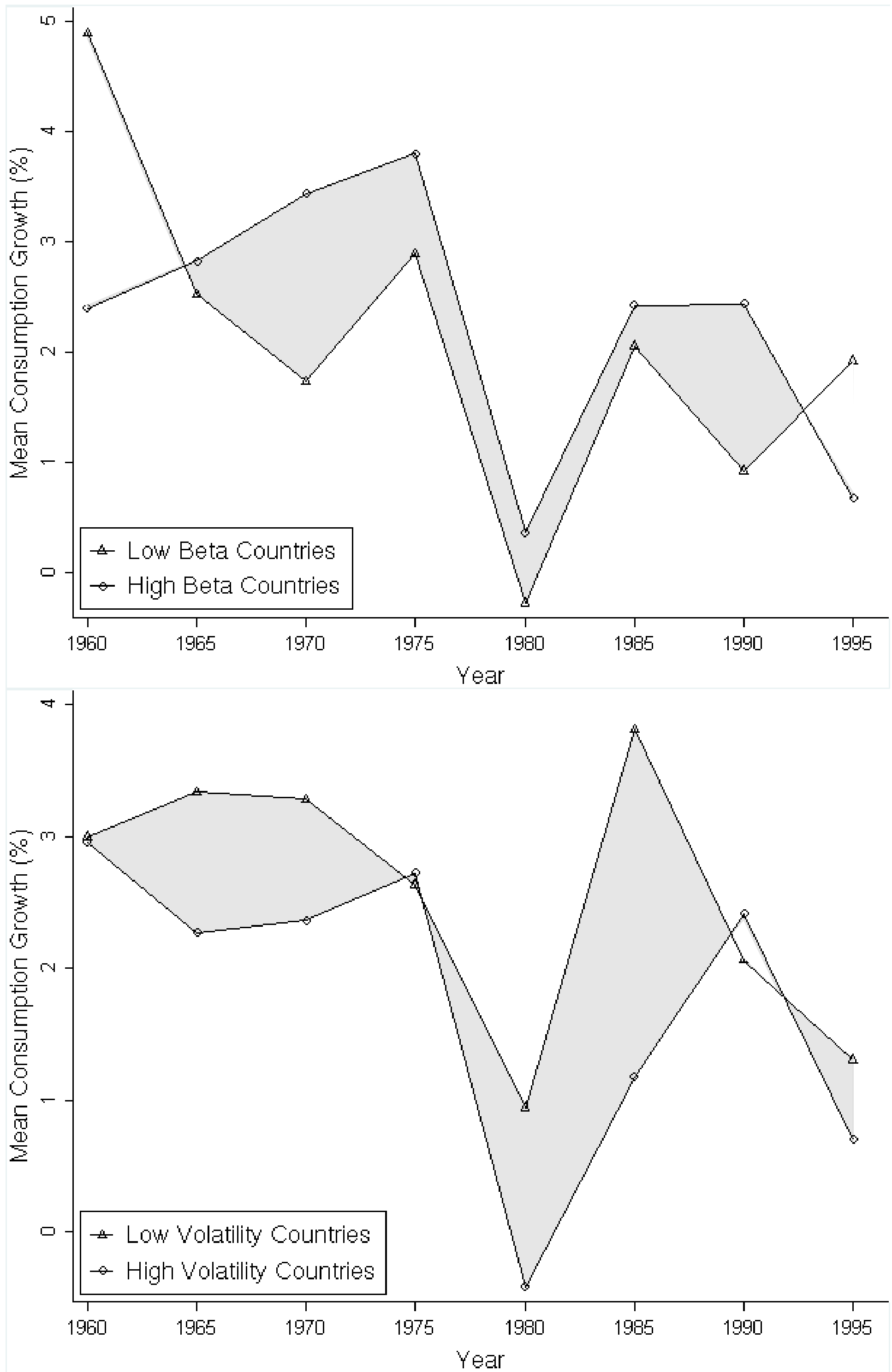

Figure 7. Consumption Growth Spread Between High and Low Beta Countries (Top Figure), and High and Low Idiosyncratic Volatility Countries (Bottom Figure). The spread is colored gray when the average consumption growth for high beta (idiosyncratic volatility) countries is greater (lower) than that for low beta (idiosyncratic volatility) countries. Countries are assigned to portfolios based on tercile breakpoints that are computed every year t in the cross-section of betas (idiosyncratic volatilities), where t = {1960, 1965, 1970,…, 1995}. Beta (idiosyncratic volatility) is measured from year t-9 to t. "High" portfolios include countries in the 3rd tercile and "low" portfolios include countries in the 1st tercile of the distribution of betas (idiosyncratic volatility) in year t. Consumption growth is computed over the 5-year interval t+1 to t+5 that follows each t.

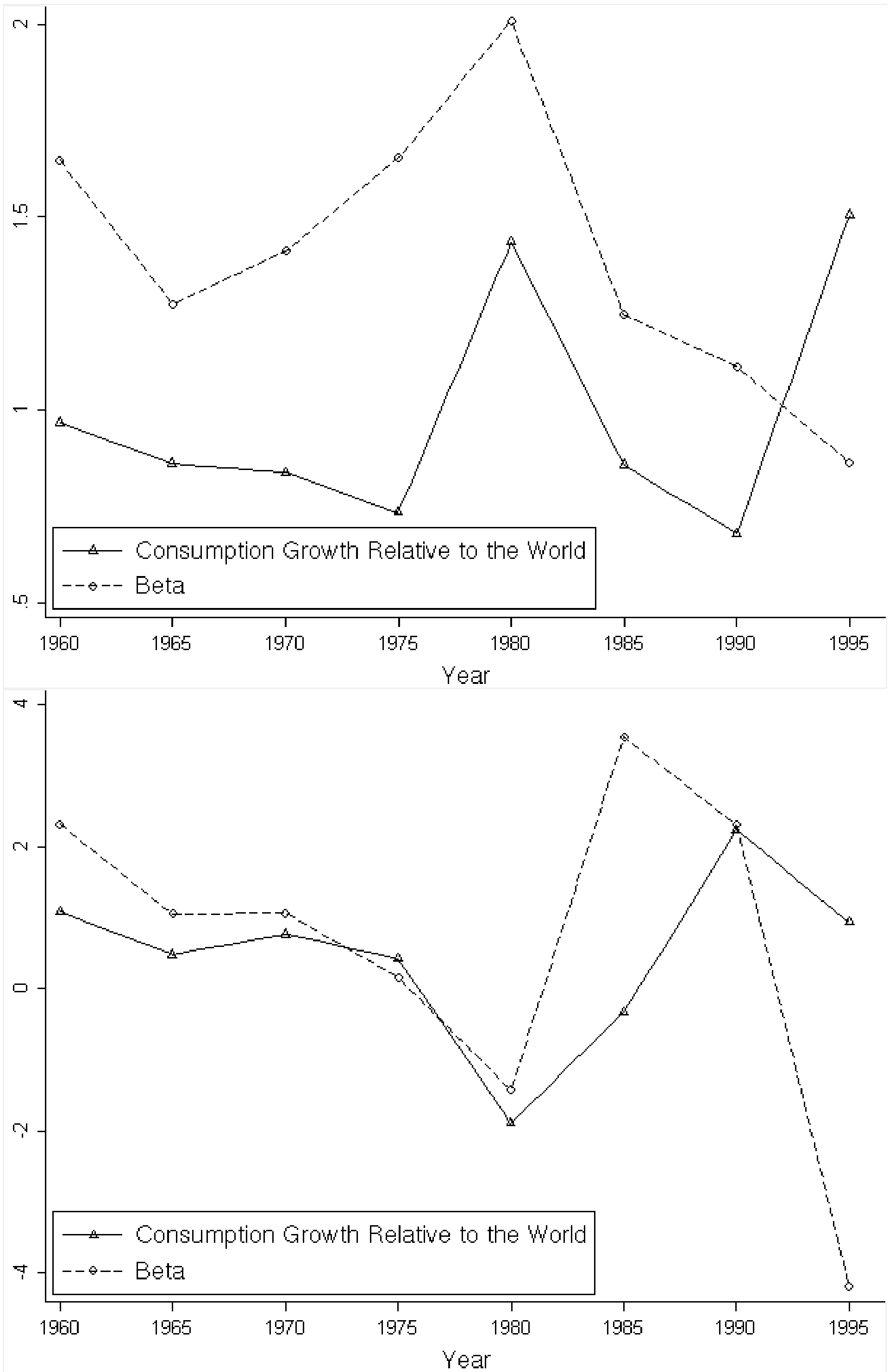

Figure 8. Time-Series of Beta and Consumption Growth Relative to the World for the U.S. (Top Figure) and Argentina (Bottom Figure). Every year t = {1960, 1965, 1970,…, 1995}, we compute annualized consumption growth over the following 5-year interval t+1 to t+5 (specifically, 1961-1965, 1966-1970, …, 1996-2000) and divide it by world consumption growth over the same time interval. Beta is estimated using data from year t-9 to t for each country.

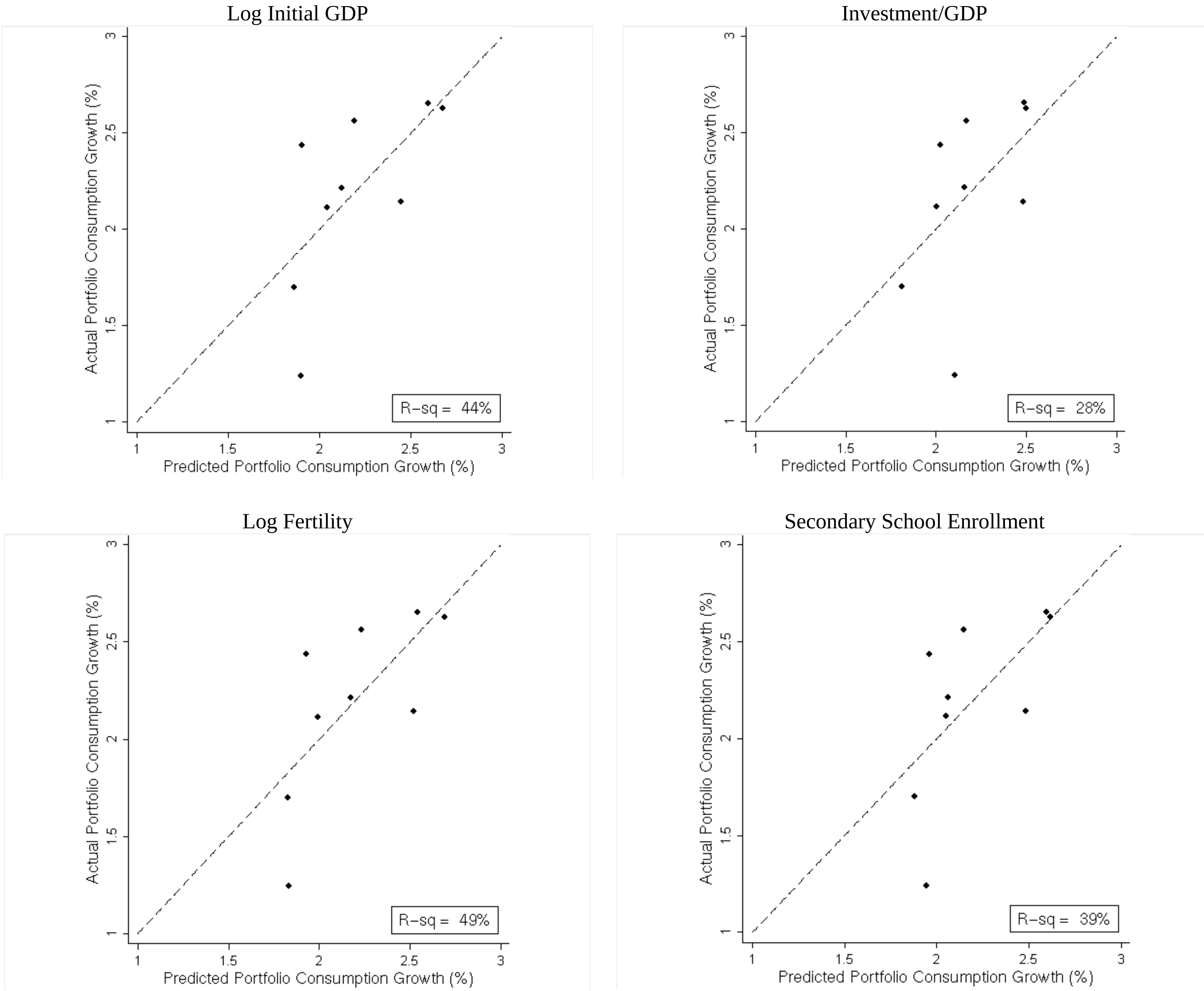

Figure 9.1. Actual Versus Predicted Consumption Growth for 9 Portfolios Sorted by Beta and Idiosyncratic Volatility. Predicted consumption growth is the fitted value from a regression of portfolio average consumption growth on portfolio averages of the variables in the headings of each panel. The dashed line is the 45 degree line. R^2 of the fit is also reported. The sorting procedure is as follows. Each year t = {1960, 1965, 1970, …, 1995} countries are assigned to one of nine portfolios based on how their beta and idiosyncratic volatility compare to the tercile breakpoints in the cross-section of betas and idiosyncratic volatility. In each portfolio we compute averages of the following variables: (1) consumption growth over 5-year non-overlapping intervals t+1 to t+5; (2) beta and idiosyncratic volatility, both measured from year t-9 to t; (3) log initial GDP measured in year t; (3) investment/GDP and (4) log fertility, both averaged over the period t-9 to t; and (5) secondary school enrollment measured in year t.

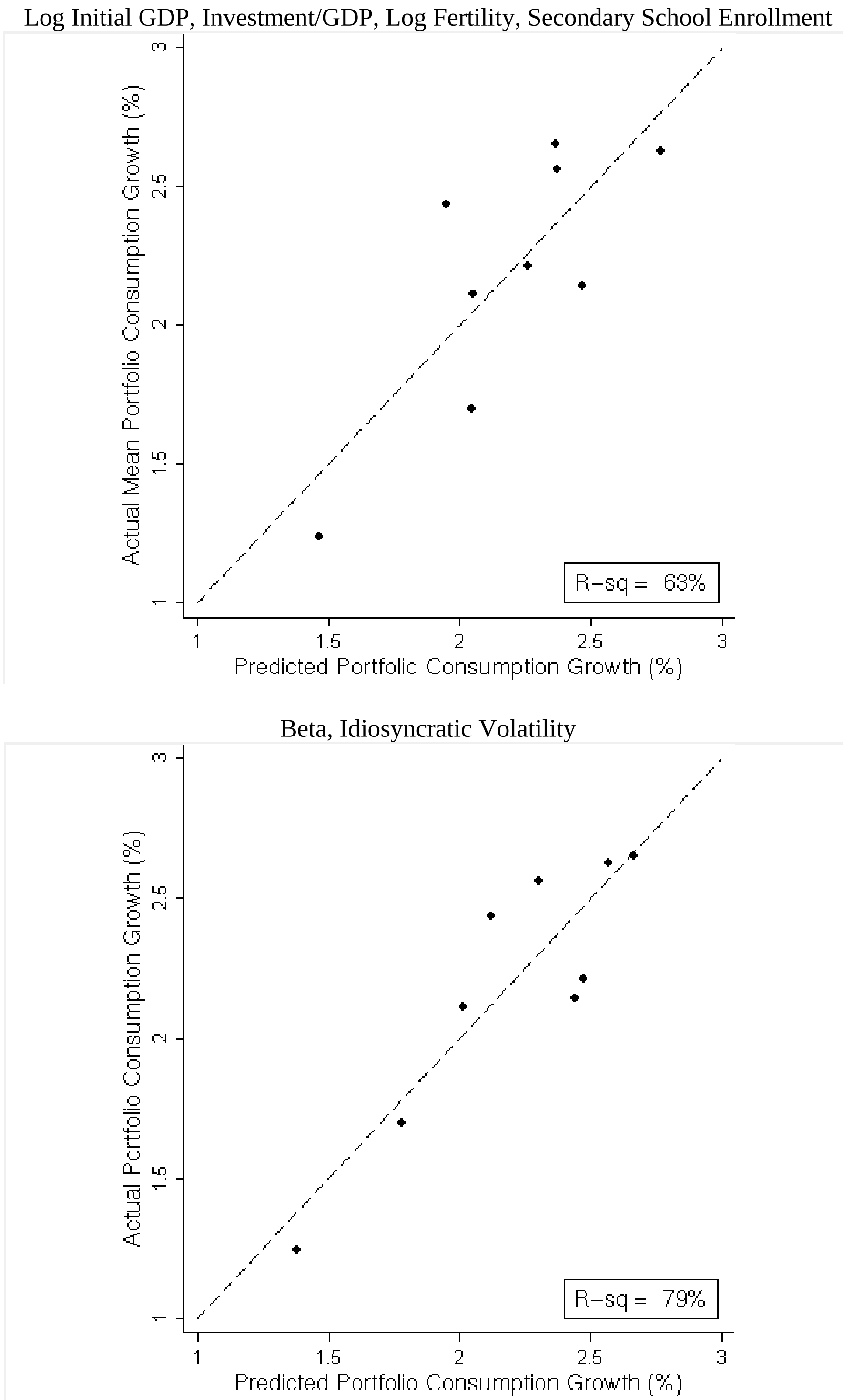

Figure 9.2. Actual Versus Predicted Mean Consumption Growth for 9 Portfolios Sorted by Beta and Idiosyncratic Volatility. See notes to figure 9.1. The top panel uses all 4 predictor variables used in figure 9.1. The lower panel uses beta and idiosyncratic volatility to predict consumption growth.

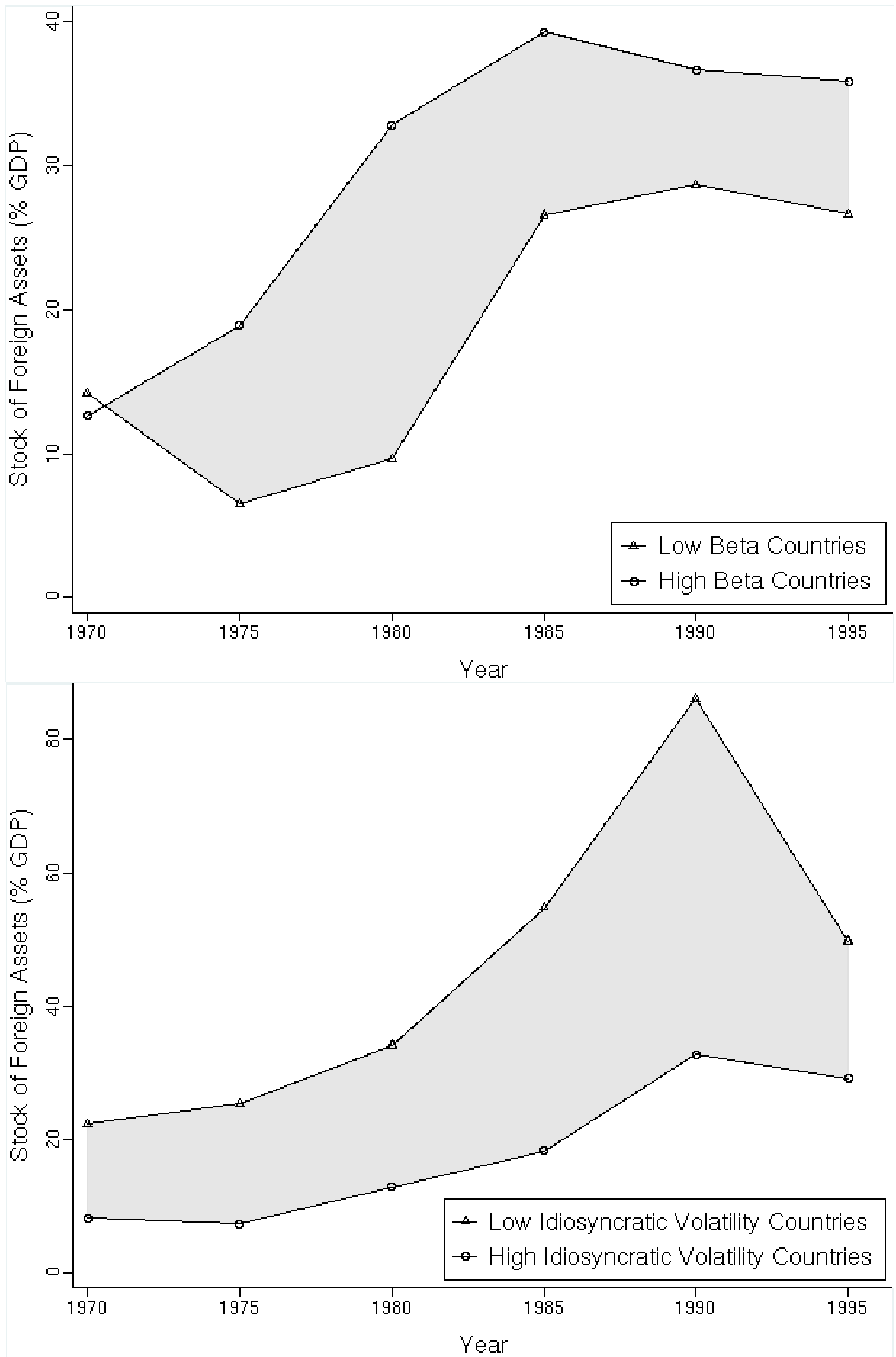

Figure 10. Spread in the Stock of Foreign Assets Between High and Low Beta (Volatility) Countries. The upper (lower) panel shows the difference in foreign assets between countries with high (3rd tercile) and low (1st tercile) betas (idiosyncratic volatilities). Countries are assigned to portfolios based on tercile breakpoints that are computed every year t for the cross-section of betas (idiosyncratic volatilities), where t = {1960, 1965, 1970,…, 1995}. For countries in each portfolio, we compute the average of the stock of foreign assets over GDP measured in year t. Beta and volatility are measured from year t-9 to t. Data on foreign assets are from Lane and Milesi-Ferretti (2001).

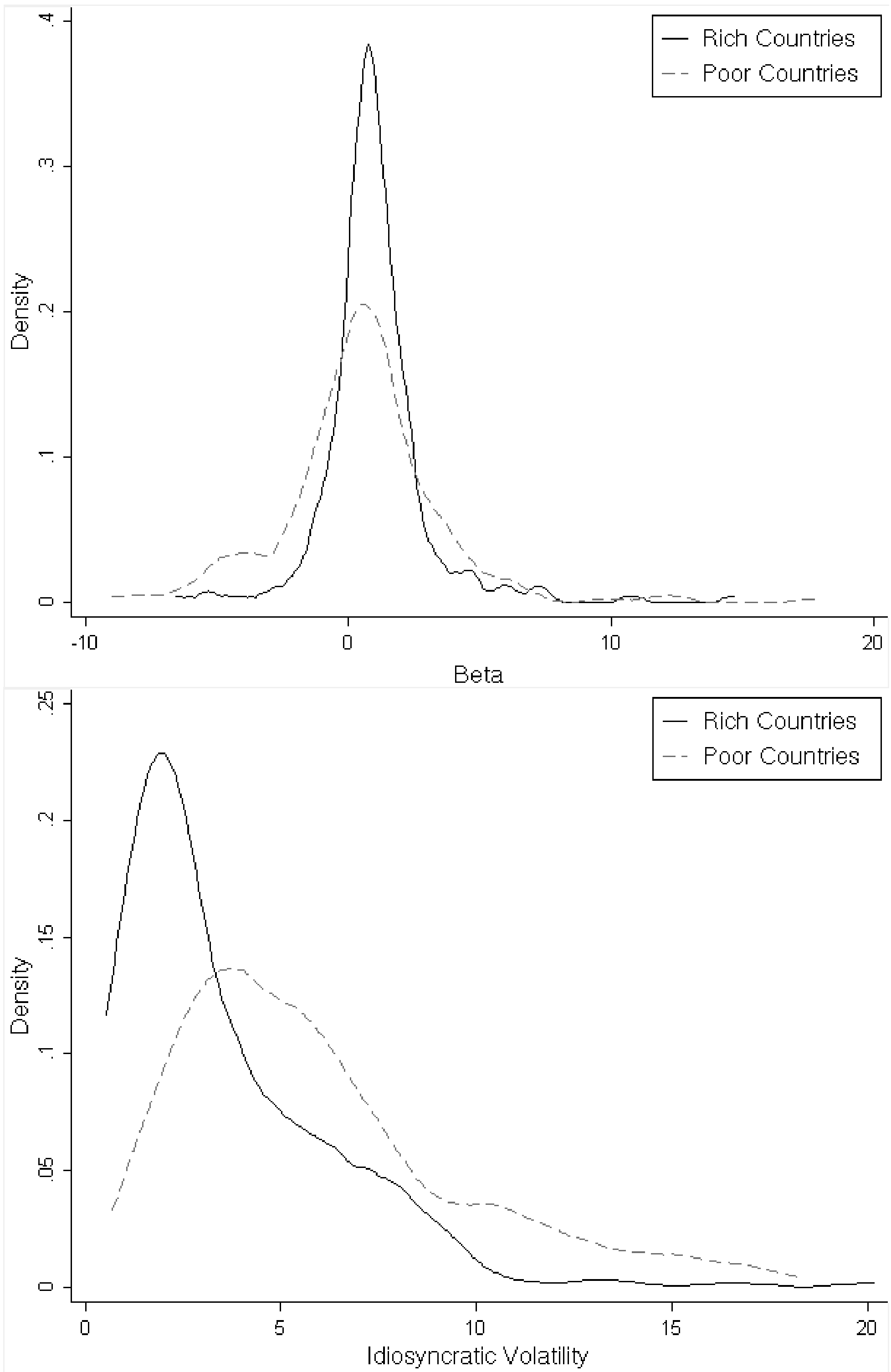

Figure 11. Distributions of Beta (Top Figure) and Idiosyncratic Volatility (Bottom Figure) for Poor and Rich Countries. Countries are grouped as "rich" or "poor" based on their real per capita GDP in year 1990 when compared to the sample median of GDP in 1990. Beta represents the regression coefficient of a country's consumption growth on world consumption growth computed every year with a backwards 10-year moving window. Idiosyncratic volatility is the standard deviation of residuals from the same regression.

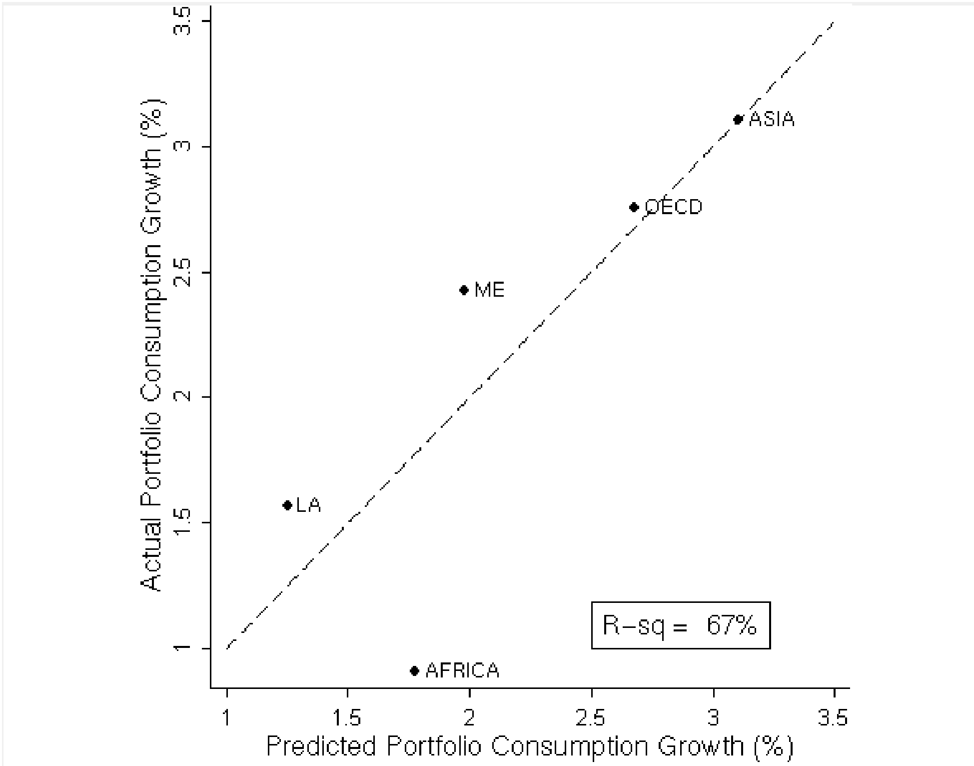

Figure A1. Actual Versus Predicted Consumption Growth for 5 Portfolios Formed on Geographical Regions. Predicted consumption growth is the fitted value from a regression of portfolio average consumption growth on portfolio average beta and idiosyncratic volatility using the five portfolio observations. The dashed line is the 45 degree line. R^2 of the fit is also reported. Countries are assigned to one of five portfolios based on their geographical location. In each portfolio we compute averages of the following variables: (1) consumption growth over 5-year non-overlapping intervals t+1 to t+5, (2) beta and (3) idiosyncratic volatility, both measured from year t-9 to t.

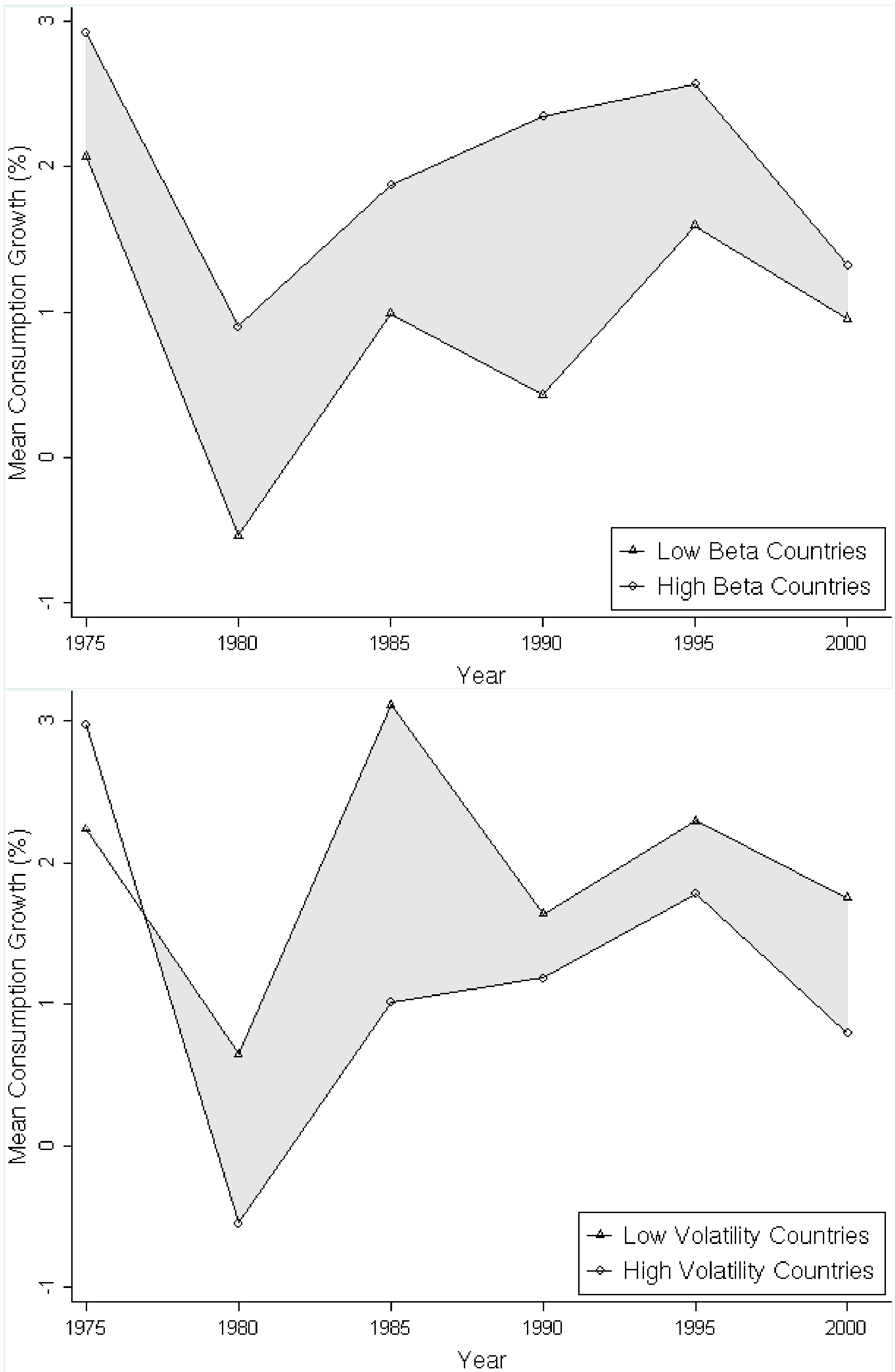

Figure A2. Consumption Growth Spread Between High and Low Beta Countries (Top Figure), and High and Low Idiosyncratic Volatility Countries (Bottom Figure): WDI sample. The spread is colored gray when the average consumption growth for high beta (idiosyncratic volatility) countries is greater (lower) than that for low beta (idiosyncratic volatility) countries. Countries are assigned to portfolios based on tercile breakpoints that are computed every year t in the cross-section of betas (idiosyncratic volatilities), where t = {1975, 1980, 1985,…, 2000}. Beta (idiosyncratic volatility) is measured from year t-9 to t. "High" portfolios include countries in the 3rd tercile and "low" portfolios include countries in the 1st tercile of the distribution of betas (idiosyncratic volatility) in year t. Consumption growth is computed over the 5-year interval t+1 to t+5 that follows each t.