

Time-Varying Risk Premia and Capital Flows to Developing Countries

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ABSTRACT

One of the most well-known puzzles in international economics is the Lucas paradox: Why doesn't capital flow from rich to poor countries? Given the low capital-output ratios in developing countries, the difference in unconditional expected returns from investing there rather than in developed markets is too high to compensate for risk alone. Hence, the Lucas paradox shares key features with well-known asset-pricing puzzles. In this paper, we study whether pricing kernels, as in [Bansal and Yaron \(2004\)](#), that can rationalize the equity-premium puzzle can also account for the Lucas paradox. [Bansal and Yaron \(2004\)](#) show that time-varying uncertainty associated with long-run trend growth shapes asset valuations. In addition, [Aguiar and Gopinath \(2007\)](#) find that shocks to trend growth are the primary source of fluctuations in emerging markets. Finally, [Borri and Verdelhan \(2012\)](#) argue that there exists a strong positive correlation between the macroeconomic conditions in developing and developed countries. The last two facts suggest that time-varying risk premia are potentially a key ingredient necessary to account for the lack of capital flows to developing countries.

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1. Introduction

One of the most well-known puzzles in international economics is the [Lucas \(1990\)](#) paradox: Why doesn't capital flow from developed to developing countries? The basic idea behind this question is as follows: It is a well-documented fact that capital-to-output ratios are substantially higher in developed than in developing countries. If production technologies are identical across countries, then measured marginal product of capital is lower in richer than in poorer countries, and hence capital should flow from the former to the latter.

Since the turn of the century, capital has been flowing “upstream” from developing countries to the United States and other developed countries as [Prasad, Rajan, and Subramanian \(2007\)](#) document — an observation that has sparked a renewed interest in resolving the paradox. In addition, [Jeanne and Gourinchas \(2011\)](#) document that there is at best zero (if not a negative) correlation between countries' growth rates and the capital inflows that they received during the 1980-2000 period. These two findings suggest that the Lucas paradox persists in an era in which developing countries have dismantled capital controls and have liberalized their financial markets.

An overlooked fact in the literature is that the Lucas paradox shares important features with well-known asset-pricing puzzles. In particular, an equivalent formulation of the Lucas paradox is that the difference between the average returns on invested capital in developing over developed countries appears to be too high to serve as compensation for traditionally-measured risk. This is analogous to the equity premium puzzle, which states that the difference in average returns on equities over bonds appears to be too high to compensate for risk or to the term premium puzzle, which refers to the excess returns on long- over short-term bonds.

In this paper, we explore whether the stochastic discount factors that have been successful in accounting for a range of asset market phenomena can reconcile the Lucas paradox. Particularly, we focus on the framework in [Bansal and Yaron \(2004\)](#), who demonstrated the importance of long-run risks — persistent shocks to growth rates and uncertainty associated with long-run growth rates — in accounting for the high equity premium, high volatility of stock returns, low and stable risk-free rate and predictability of stock returns. Subsequent work has used these shocks to account for the term structure and uncovered interest rate parity, the return premium on value stocks and small stocks, the term structure of equity returns, and the volatility of real exchange rates.¹

We identify two key ingredients that are necessary to quantitatively account for the high risk

¹Important papers include [Bansal and Shaliastovich \(2010\)](#), [Bansal, Dittmar, and Lundblad \(2005\)](#), [Hansen, Heaton, and Li \(2008\)](#), [Bonomo, Garcia, Meddahi, and Tdongap \(2011\)](#), [Malloy, Moskowitz, and Vissing-Jørgensen \(2009\)](#), [Croce, Lettau, and Ludvigson \(2007\)](#), and [Colacito and Croce \(2011\)](#). See [Bansal, Kiku, and Yaron \(2009\)](#) for a comprehensive review of the literature.

premium associated with capital flows to developing countries. First, investment risk in poor countries must be highly time varying. Second, the time variation in the price of the investment risk in developing markets must be positively correlated with the price of risk in developed economies. These two facts have been recently documented. [Aguiar and Gopinath \(2007\)](#) find that shocks to trend growth—rather than transitory fluctuations around a stable trend—are the primary source of fluctuations in emerging markets. In addition, [Borri and Verdelhan \(2012\)](#) rely on financial data to argue that there exists a strong positive correlation between the macroeconomic conditions in developing and developed countries. The last two facts suggest that time-varying risk premia are potentially key to account for the lack of capital flows to developing countries.

We quantify the importance of time-varying risk premia in reconciling the Lucas paradox within a framework that features recursive preferences and shocks to trend growth rates. The model economy builds on the [Bansal and Yaron \(2004\)](#) one-country endowment economy. Consumer preferences have the recursive structure described by [Kreps and Porteus \(1978\)](#), [Epstein and Zin \(1989\)](#), and [Weil \(1989\)](#). We extend the basic framework along three dimensions: First, as in [Colacito and Croce \(2011\)](#), we consider a two-country model with one “mature” and one “emerging” market calibrated to the growth-dynamics characteristics of developed and developing countries, respectively. Second, as in [Kaltenbrunner and Lochstoer \(2010\)](#) and [Schmid and Kung \(2011\)](#), we study production economies and we allow for capital accumulation and endogenous cross-country capital flows. Third, we draw on [Aguiar and Gopinath \(2007\)](#) and [Nakamura, Sergeyev, and \(2012\)](#) to quantify long-run risks in developed and developing countries.

Overall, we contribute to a large literature that attempts to justify the small flows of capital from rich to poor countries — the Lucas paradox. [Caselli and Feyrer \(2007\)](#) argue that higher prices of investment and lower efficiency levels in poor countries reduce marginal products of capital there to levels that are comparable to those of developed countries. In contrast, [Gertler and Rogoff \(1990\)](#), [Boyd and Smith \(1997\)](#), [Matsuyama \(2005\)](#), [Castro, Clementi, and MacDonald \(2004\)](#), [Caballero, Farhi, and Gourinchas \(2008\)](#), [Mendoza, Quadrini, and Rios-Rull \(2009\)](#), and [Buera and Shin \(2009\)](#) offer explanations that build on frictions in international (and especially in developing countries’) financial markets. To our knowledge, our paper is the first to consider an explanation of the Lucas puzzle that relies on time-varying risk premia.

2. Sketch of model economy

There are two countries: mature, m , and emerging, e . In each country an intermediate good is produced which is traded internationally, and a final good is produced using the two intermediate goods as inputs. For convenience we will occasionally refer to the final good produced in country $i \in \{m, e\}$ as “final good i ”, and the intermediate good produced in country i as

“intermediate good i ”. International financial asset markets are complete.

2.1. Uncertainty

Time is discrete. Each period there is a realization of a random event z_t , which denotes shocks to productivity growth in the two countries. In general, allocations in period t are functions of the history of these shocks up to and including time t , the initial values for capital stocks $K_{i,0}$, and the asset holdings $A_{i,0}$ for $i \in \{e, m\}$. For convenience we let $z^t = (K_{h,0}, K_{f,0}, A_{h,0}, A_{f,0}, z_0, z_1, \dots, z_t)$ denote the vector of initial values and the history of events up to and including time t .

2.2. Environment

Preferences have the now-familiar recursive structure described by [Kreps and Porteus \(1978\)](#), [Epstein and Zin \(1989\)](#), and [Weil \(1989\)](#). If U_t is “utility from date t on,” preferences follow from the time aggregator V ,

$$U_t = V[c_t, \mu_t(U_{t+1})] = [(1 - \beta)c_t^\rho + \beta\mu_t(U_{t+1})^\rho]^{1/\rho}, \quad (1)$$

and (expected utility) certainty equivalent function μ ,

$$\mu_t(U_{t+1}) = [E_t(U_{t+1}^\alpha)]^{1/\alpha}. \quad (2)$$

The conventional interpretation is that $\rho < 1$ captures aversion against short-term consumption fluctuations and $\alpha < 1$ captures aversion towards uncertainty associated with long-run welfare. Additive utility is a special case with $\alpha = \rho$.

Both the time aggregator and the certainty equivalent function are homogeneous of degree one, which allows us to scale everything by current consumption and convert our problem to one in growth rates. If we define scaled utility $u_t = U_t/c_t$, equation (1) can be expressed as

$$u_t = [(1 - \beta) + \beta\mu_t(g_{t+1}u_{t+1})^\rho]^{1/\rho}, \quad (3)$$

where $g_{t+1} = c_{t+1}/c_t$ is the growth rate of the endowment/consumption.

With these preferences, the pricing kernel is

$$\begin{aligned} m_{t+1} &= \beta(c_{t+1}/c_t)^{\rho-1} [U_{t+1}/\mu_t(U_{t+1})]^{\alpha-\rho} \\ &= \beta g_{t+1}^{\rho-1} [g_{t+1}u_{t+1}/\mu_t(g_{t+1}u_{t+1})]^{\alpha-\rho}. \end{aligned} \quad (4)$$

The pricing kernel is the heart of any asset pricing model, so (4) is central to the properties of asset prices and returns. The last term is the contribution of recursive preferences. If $\alpha = \rho$, it drops out, but in general the difference between α and ρ affects how predictable changes in

consumption growth and its volatility are priced.

The budget constraint of the representative decision maker in country m is given by

$$c_{m,t}(z^t) + x_{m,m,t}(z^t) + x_{m,e,t}(z^t) = w_{m,t}(z^t) + r_{h,t}(z^t)\omega_{m,m}K_{m,t}(z^{t-1}) + r_{h,t}(z^t)\omega_{m,e}K_{e,t}(z^{t-1})$$

Here $c_{m,t}(z^t) \geq 0$ is units of consumption of the final good in country m , $x_{m,i,t}$ are the investments the representative decision maker from country m makes in country i , $K_{i,t}(z^{t-1})$ is the capital stock in country i at the beginning of period t measured in terms of country i consumption units, and $\omega_{m,i}$ is the fraction that the representative decision maker in country m owns of the capital stock in country i .

The budget constraint for country e is similar, but written in terms of the final good in that country.

The capital evolution equation in country i – with adjustment costs – is

$$K_{i,t+1}(z^t) = (1 - \delta)K_{i,t}(z^{t-1}) + x_{i,i,t}(z^t) + x_{j,i,t}(z^t) - \Phi(K_{i,t}, x_{j,i,t}, x_{i,i,t})$$

where δ is the rate of depreciation, which is the same across countries, and Φ is the adjustment cost.

2.3. Firms

In each country there are producers of intermediate and final goods. In this section we describe these firms' problems and the process for productivity in the two countries.

2.3.A. Final goods production

A representative firm in the final goods sector produces using a CES production function where the inputs are the intermediate goods produced in both countries. In each country there is a bias in the final goods production towards the intermediate good produced in that country. The demand for intermediate good i in country j is denoted by $I_{ij,t}$ for $i, j \in \{m, e\}$. The production functions for the final goods in the two countries are given by

$$G_h(I_{mm,t}(z^t), I_{me,t}(z^t)) = \left[\eta(I_{mm,t}(z^t))^{\frac{\sigma-1}{\sigma}} + (1 - \eta)(I_{me,t}(z^t))^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$$

$$G_f(I_{em,t}(z^t), I_{ee,t}(z^t)) = \left[(1 - \eta)(I_{em,t}(z^t))^{\frac{\sigma-1}{\sigma}} + \eta(I_{ee,t}(z^t))^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$$

The parameter σ is the elasticity of substitution between the two intermediate goods, and home bias in final goods production is given by each country putting weight $\eta > .5$ on the intermediate good produced in that country

2.3.B. Intermediate goods production

In each country, a representative firm in the intermediate goods sector produces using capital and labor with a standard constant returns to scale production function. These firms take prices of goods and factor inputs as given.

2.4. Productivity

As a starting point, we follow Rabanal, Rubio-Ramirez, and Tuesta (2011) and we let $\log Z_{m,t}$ and $\log Z_{e,t}$ be cointegrated of order $C(1, 1)$. The law of motion for the log-first differences of productivity in the home and the foreign country is specified by the following VECM:

$$\begin{pmatrix} \Delta \log Z_{m,t} \\ \Delta \log Z_{e,t} \end{pmatrix} = \begin{pmatrix} \phi_{0m} \\ \phi_{0e} \end{pmatrix} + [\log Z_{m,t-1} - \kappa \log Z_{e,t-1}] \begin{pmatrix} \phi_{1m} \\ \phi_{1e} \end{pmatrix} + \begin{pmatrix} \epsilon_{m,t} \\ \epsilon_{e,t} \end{pmatrix}$$

2.5. Equilibrium

We are in the process of solving for the equilibrium of the model and computing the implied cross-country capital flows.

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