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Abstract

We introduce habit formation in a model that studies the link between international trade in financial assets, economic growth, and welfare. As with time separable preferences asset trade increases the mean growth rate, but it also increases growth-volatility. We demonstrate that the welfare gain from asset trade is lower with habit persistence in consumption. This reflects that the habit-forming households perceive the higher growth-volatility as a higher cost to obtain increased average growth. Calibrating the model to data for North America and Western Europe, we find that habit persistence lowers welfare gains of financial integration by about 40-50 %.

JEL classification: E44, F21, G15

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1. Introduction

An important function of international financial markets is to facilitate diversifying and pooling of nation-specific risks. This allows agents from different countries to obtain smoother consumption paths, holding expected growth rates fixed. In addition, the ability to diversify risk affects the optimal, temporal and intertemporal, allocation of resources (e.g., portfolio allocation and saving rates), which, in turn, can influence economic growth.[1] Thus, trade in financial assets may have important macroeconomic effects because it alters both the growth and volatility of national consumption paths.

The purpose of this paper is to study how the international financial system's ability to pool country-specific technological risk affects growth and welfare, when agents exhibit habit persistence in consumption. The motivation for introducing habit formation in an analysis of international risk sharing is twofold.

First, models incorporating habit persistence have been relatively successful in resolving the equity-premium/ risk-free rate puzzles of Mehra and Prescott (1985) and P. Weil (1989).[2] Since Campbell (1999) has documented the existence of these puzzles for several OECD-countries, it seems relevant to take them into account also in international settings. Still, existing models evaluating the link between international asset trade and economic growth - which are very similar in structure to asset-pricing/portfolio-selection models - do not attempt to include habit formation (Devereux and Smith, 1994; Obstfeld, 1994; Devereux and Saito, 1997; Dumas and Uppal, 2001).

Second, one of the main messages from the asset-pricing literature is that habit persistence generates endogenous, time-varying attitudes towards risk (e.g., Constantinides, 1990; Campbell and Cochrane, 1999). One of the determinants of risk-aversion in these models is the investment opportunity set that the agents face. Of course, this set will be altered by the opportunity to diversify risk internationally. Thus, with habit formation in consumption, trade in financial assets can influence economic growth both through direct changes in the technology available and through induced changes in household behavior. A model with intertemporal dependent preferences could accordingly deepen our understanding of the link between the trade in financial assets, economic growth, and welfare.

[1] See Levine (1997) for a recent survey on the relationship between financial development and economic growth. See also Acemoglu and Zilibotti (1997) on the link between the ability to diversify, risk-taking, and growth.
[2] Among others, Abel (1990), Constantinides (1990), Bakshi and Naka (1997) and Campbell and Cochrane (1999) demonstrate the potential for explaining the puzzles within a habit formation model. For a different view, see Kocherlakota (1996).

This paper considers a model where production takes place through linear technologies in which capital is the only factor of production. Since this implies constant returns to scale in the input, the resulting equilibrium is characterized by ongoing endogenously determined growth. As in Obstfeld (1994), the set of technologies consists of one risk-free and one risky type in each country. The risky technology has a higher expected return than the risk-free. Thus, the equilibrium growth rate depends on both total savings and on the allocation of investment between the technologies.

Our main finding is that habit formation, compared to the case of time separable utility, leads to lower welfare gains from financial integration. This result is due to a combination of high, time-varying risk-aversion and the presence of a common (across countries) risk-free technology: Risk-aversion is a function of the difference between current and past consumption (the habit level). When this difference approaches 0, risk-aversion goes to infinity. Then, households won't tolerate any fluctuations and will invest in the risk-free technology only. Since this technology is common across countries, there will not be any reallocation of resources upon financial integration, and welfare will be unchanged. At the other extreme, risk-aversion goes to its lower bound when the difference between current consumption and the habit level is very large. It turns out that this lower bound is equal to the (constant) level of risk-aversion with time separable utility. In this case, the optimal response to the asset-trade possibility is equal with or without habit formation, as is the welfare gain. In intermediate cases, the welfare gain from financial integration is positive, but smaller than with time separable utility. Our baseline calibration in section 4 below implies that habit persistence lowers the gains by about 40-50 %.

We also show that opening up to international asset trade increases the expected consumption growth rate, but it also gives higher growth volatility. This is true for both habit forming and time separable preferences and our main result above can be viewed as a corollary of this. Habit-forming households perceive the increased growth-variability as a higher cost to obtain higher average growth.

The rest of this paper is organized as follows: Section 2 explores the growth and welfare properties of a simple closed-economy, habit formation model. Section 3 extends the model to a symmetric multi-country world with free asset trade. The impact of asset trade on consumption growth, growth-volatility and welfare in the habit persistence model are compared to the time separable case. In section 4 we calibrate the model using stock-market data for Western Europe and North America. Section 5 provides a discussion of the findings and of some possible extensions.

2. Individual choice and equilibrium in a closed economy

We start by considering a closed economy with a constant population (normalized to 1) of identical households that lives forever. There is a single physical good in the economy, which may be allocated to consumption or investment, and all values are expressed in terms of units of this good. As in the seminal paper of Cox et al. (1985), production possibilities consist of a set of linear technologies in which capital is the only input. In the closed economy, the set is restricted to two types of technologies. One has a sure rate of return equal to rdt over the period $[t, t + dt]$, while the other obeys the geometric diffusion process: $\alpha dt + \sigma dz_t$ over $[t, t + dt]$, where dz_t represents a standard wiener process with zero mean, and α and σ are constants. The constant returns associated with both types of technologies imply that the model is one of endogenous growth. The only source of uncertainty in the economy is the rate-of-return risk associated with the risky technology.

At time t, the representative household has capital W_t and faces the decisions of how much of it to save and how to allocate savings between the two technologies. To make the portfolio choice non-trivial, it is assumed that $\alpha > r$. By denoting ω_t as the time t fraction of wealth invested in the risky asset and the time t consumption by c_t, the instantaneous change in capital will be given by:

$$dW_t = \left[\omega_t\alpha + (1-\omega_t)r\right]W_t dt + \omega_t\sigma W_t dz_t - c_t dt. \tag{1}$$

Capital per capita is equal to wealth per capita in this model, so equation (1) also describes the wealth dynamics in the closed economy.

At time 0, the representative household maximizes the intertemporal objective function

$$U_0 = E_0\left[\int_0^\infty u\left(c_t, x_t\right)\mathrm{e}^{-\delta t}dt\right], \tag{2}$$

where E_0 is the conditional expectations operator and $\delta > 0$ is the subjective rate of time preference. The instantaneous utility of the households, $u(\bullet)$, depends on the prevailing consumption level as well as the habit level (x_t). The idea in the habit formation literature is that the utility derived from a given level of current consumption is lower, the higher the habit level. We assume that the instantaneous utility function is given by

$$u(c_t, x_t) = \frac{(c_t - x_t)^{1-\gamma}}{1-\gamma}, \tag{3}$$

where $\gamma > 0, \neq 1$, is a utility curvature parameter. Later, we will find it convenient to capture the relation between consumption and habit by the state variable $s_t \equiv (c_t - x_t)/c_t$. As Campbell and Cochrane (1999) we refer to s_t as the surplus consumption ratio. By (3), this ratio is the fraction of consumption that is available to generate utility at each point in time. The marginal utility of consumption goes to infinity as c_t approaches x_t, implying that the households will never permit consumption to fall below the habit level.

We follow Ryder and Heal (1973) in assuming that the habit level is a simple weighted average of past consumption:[3]

$$x_t = e^{-\beta t} x_0 + \beta \int_0^t c_\tau e^{-\beta(t-\tau)} d\tau, \tag{4}$$

where $t \geq \tau$ and $\beta \geq 0$ is a parameter that determines the relative weight of consumption in earlier time periods. The larger is β, the more important is consumption in the recent past. If $\beta = 0$, the habit level is equal to some predetermined standard $x_0 \geq 0$. The special case $\beta = x_0 = 0$ corresponds to standard time separable preferences. By equation (4), the habit level responds linearly to past consumption, evolving according to

$$dx_t = \beta\left(c_t - x_t\right) dt. \tag{5}$$

The representative household chooses c_t and ω_t to maximize (2), subject to (1), (5) and the initial period wealth endowment W_0. Sundaresan (1989) and Constantinides (1990) show that the value function

$$J(W_t, x_t) = \Theta(W_t - \frac{x_t}{r})^{1-\gamma}, \tag{6}$$

where $\Theta = \dfrac{r^{1-\gamma}}{\left(\beta + r\right)^{1-\gamma}\left(1-\gamma\right)}\left[\dfrac{\gamma}{\delta - (1-\gamma)\left(r + \frac{(\alpha - r)^2}{2\gamma\sigma^2}\right)}\right]^{\gamma}$, solves this problem. The optimal consumption policy is

$$c_t = x_t + \left(W_t - \frac{x_t}{r}\right)\mu, \tag{7}$$

where $\mu \equiv \frac{r}{(\beta + r)}\eta$, and $\eta \equiv \frac{1}{\gamma}\left[\delta - (1-\gamma)\left(r + \frac{(\alpha - r)^2}{2\gamma\sigma^2}\right)\right] > 0$. Asset demand in equilibrium is given by

$$\omega_t = \lambda\left(1 - \frac{x_t}{rW_t}\right), \tag{8}$$

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[3] For a more complex specification of the habit evolution, see Campbell and Cochrane (1999).

where the constant $\lambda \equiv \frac{\alpha - r}{\gamma\sigma^2}$.

Both the consumption policy (7) and the investment behavior (8) vary over time, depending on the lognormally distributed (Constantinides, 1990) difference $W_t - x_t/r$. This contrasts time separable preferences (i.e. when $\beta = x_0 = 0 \Rightarrow x_t = 0$) as the consumption policy and asset demand then would be given by $c_t = \eta W_t$ and $\omega = \lambda$, respectively (Merton, 1969).

It is illustrative to rewrite (7) and (8) in terms of the surplus consumption ratio and relative risk-aversion of the habit formation model. Relative risk-aversion is given by $R \equiv -WJ_{WW}/J_W$. From equation (6) we obtain

$$R(s_t) = \frac{\gamma}{1 - \frac{x_t}{rW_t}} = \gamma\left[1 + \tfrac{\mu}{r}\left(\tfrac{1-s_t}{s_t}\right)\right] \geq \gamma, \tag{9}$$

where the second equality follows from the definition of s_t and substitution of W_t from (7). We see that R_t is falling in s_t and approaches γ as $s_t \to 1$. As is well known, γ is the coefficient of relative risk-aversion in the case of isoelastic time separable expected utility preferences. This coefficient provides a lower bound on risk-aversion with habit formation. Generally, equation (9) tells us that risk-aversion is high when the surplus consumption ratio is low, i.e. in 'bad times' when consumption is close to the habit level.

From equations (8) and (9), the optimal portfolio share in the risky technology can be written as

$$\omega_t = \lambda \frac{\gamma}{R(s_t)}. \tag{10}$$

A low realization of s ('bad times') implies that risk aversion will be high and, accordingly, a small fraction of wealth will be invested in the risky asset. In the limit, when $c_t \to x_t$, risk-aversion goes to infinity and all investment will be in the risk-free asset. Conversely, R_t approaches γ when s_t is very large, implying that $\omega_t = \lambda$ as in the time separable case. In the economy with habit formation risk taking is time varying, but always (weakly) lower than with time separable preferences.

The first equality in (9) implies that $x_t/W_t = r(1 - \gamma/R_t)$, which can be used in equation (7) to derive the consumption/wealth ratio:

$$\frac{c_t}{W_t} = \frac{\gamma}{R(s_t)}(\mu - r) + r. \tag{11}$$

The impact of changes in the surplus consumption ratio on savings (as measured by c/W), depends on the difference $\mu - r$. For 'reasonable' parameter values this difference will be negative,[4] in which case low realizations of s_t (high R_t) give a larger consumption/wealth ratio. When the surplus consumption ratio is very large c/W will be equal to μ, which compares to $c/W = \eta > \mu$ in the time separable case. Thus, with equal risk aversion (which is the case when $s_t \to 1$), the *allocation* of savings is identical with and without habit formation (from equation (10)), but *total* savings are higher with habit formation.

When $s_t \to 0$ ($R_t \to \infty$), the consumption/wealth ratio is r. Appealing again to plausible parameter values, we have $r > \mu$, so that the consumption-wealth ratio is higher the smaller is s_t. It may seem counterintuitive that savings are smaller when consumption is close to the habit level, i.e. in 'bad times'. This result is related to the degree of risk aversion and precautionary saving. When R_t is very large, the household invests in the risk-free asset only. Then it is optimal to consume the permanent income from the investment: rW. As the degree of relative risk-aversion falls, it becomes optimal to invest an increasing fraction of wealth in the risky asset. This implies that income becomes stochastic, which triggers precautionary saving and consequently increases total savings.

To provide a discussion of the model's growth properties, we impose the restriction that $0 \le \lambda \le 1$. This assumption implies that $0 \le \omega_t \le 1$, see equation (10), which ensures interior solutions characterized by a positive investments in both technologies.[5]

Constantinides (1990) shows that the unconditional mean consumption growth rate of this economy is[6]

$$g = E[s](k+\beta) = (k+\beta)\int_0^1 s\pi_s(s)\,ds, \tag{12}$$

where

$$k \equiv \frac{r-\delta}{\gamma} + \frac{(1+\gamma)(\alpha-r)^2}{2\gamma^2\sigma^2}. \tag{13}$$

$\pi_s(s)$ is the probability density function of the surplus consumption ratio:

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4 From the definition of μ we can find that $\mu - r < 0$ if $\beta > \eta - r$. Hence, the validity of our reasonability statement hinges partly on the size of β. Habit formation models used to explain the equity premium puzzle rely on a high value of β. Constantinides (1990), for instance, calibrate his model to annual data using values of β as high as 0.6. Habit formation models in the growth literature rely on somewhat lower values. E.g., Ryder and Heal (1973) argue that β should be in the range of 0.1-0.3, and Carroll et al. (2000) use $\beta = 0.2$ as their baseline assumption. What about the RHS of the inequality above? For typical values of the parameters entering η this difference is in the order of –0.03 to 0.03. The parameter values given table 1 and 2 below imply, for example, that $\eta - r \approx 0.01$. Based on the values of β used in related literature, it thus seems reasonable to assume that $\beta > \eta - r$.

5 Interior solutions are necessary for the equilibrium to be consistent with a constant risk-free interest rate.

$$\pi_s(s) = \mathrm{M}s^{-2}\left(\frac{s}{1-s}\right)^{\frac{2k}{\lambda^2\sigma^2}} \exp\left(-\frac{2\beta}{\lambda^2\sigma^2}\frac{s}{1-s}\right), \tag{14}$$

$$0 < s \leq 1,$$

where M is a constant:

$$\mathrm{M} = \left(\frac{2\beta}{\lambda^2\sigma^2}\right)^{2k/\lambda^2\sigma^2-1} \Big/ \Gamma\left[\frac{2k}{\lambda^2\sigma^2}-1\right], \tag{15}$$

and Γ[•] is the gamma function. Noting that c has a stationary distribution as s[7], we can interpret g as the expected steady state growth rate of consumption. This growth rate is a function of the model parameters and of the state variable x_t, which appears in the surplus consumption ratio.

In the case of time separable preferences, the mean consumption growth rate would be equal to k. Equation (12) reveals that it could be either lower or higher than this if preferences are characterized by habit formation. If the expected surplus consumption ratio is large, the expected growth rate will be high. At the extreme when $E[s] \to 1$, g will approach $k + \beta > k$. Portfolio allocation will be identical with or without habit formation in this case, but savings will be higher with habits (confer our discussion above). Conversely, the expected growth rate is low in if $E[s]$ is small. In the limit when $E[s] \to 0$ the growth rate will approach $0 < k$, as the consumer will invest in the risk-free asset only and consume the return from this asset (rW) in every 'period'.

The instantaneous variance of the steady state growth rate can be obtained from equation (12):

$$\frac{\mathrm{var}\left[dc/c\right]}{dt} \equiv \sigma_c^2 = (\lambda\sigma)^2 \int_0^1 s^2 \pi_s(s)\, ds \tag{16}$$

We notice that the consumption variance with time separable preferences would be $(\lambda\sigma)^2$. Habit formation implies a smoother consumption path. The reason is that, ceteris paribus, the fraction wealth invested in the risky asset will be lower in an economy characterized by habit persistence. Since return shocks are the only source of uncertainty, the economy evolves with smaller disturbances.

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[6] The formulas given in Constantinides are slightly different, since the habit stock in his model evolves according to $dx_t = (bc_t - ax_t)dt$, as compared to our equation (5). If we set $a = b = \beta$ in Constantinides' model, we obtain equations (6) - (8) and (12) - (15).

[7] Stationarity of the distribution of s requires $k - \lambda^2\sigma^2 > 0$, which we assume.

Before proceeding to the analysis of financial integration, it is helpful to demonstrate how changes in the technology-parameters α and σ affect welfare. Lifetime utility is given by equation (6). This equation can be rewritten by observing that equation (13) implies that

$$r+\frac{(\alpha-r)^2}{2\gamma\sigma^2}=\frac{\delta+\gamma(k+r)}{1+\gamma}.$$

Substituting this expression into (6) we obtain:

$$J(W_t,x_t)=\frac{r^{1-\gamma}}{(\beta+r)^{1-\gamma}(1-\gamma)}\left(\frac{1+\gamma}{2\delta-(1-\gamma)(k+r)}\right)^{\gamma}\left(W_t-\frac{x_t}{r}\right)^{1-\gamma}. \tag{17}$$

Shifts in α and σ influence lifetime utility (from time t and onward) only through their effect on k. Since J is increasing in k, higher α or lower σ will increase welfare. In an economy characterized by time separable preferences, we would have $\beta = x_t = 0$. It is then easy to see that lifetime utility would be

$$J(W_t)=\frac{1}{1-\gamma}\left(\frac{1+\gamma}{2\delta-(1-\gamma)(k+r)}\right)^{\gamma}W_t^{1-\gamma}. \tag{18}$$

The welfare increase due to a rise in α or a fall in σ is common for both types of economies.

3. Habit persistence and the gains from international risk sharing

3.1 Multi-country equilibrium with frictionless trade in financial assets

In order to introduce habit formation in Obstfeld's (1994) multi-country model, we assume that the representative household in country i (i = 1, 2,..., N) has preferences specified by (2), (3) and (4). Preferences are nation specific, since country i has a rate of time preference δ_i, a habit smoothing constant β_i, and a utility curvature parameter γ_i. We assume that expectations are homogenous across consumers from all countries. Specifically, consumers from all countries perceive the risky asset return in country i to be governed by the diffusion process $\alpha_i dt+\sigma_i dz_{i,t}$, for i = 1,...,N, over the period [t, $t + dt$]. Thus, the expected return and risk associated with the risky technology in the different countries may be unequal. The cross-country correlation in the rates of return are represented by the structure $dz_i dz_j=\rho_{ij}dt$, with $\mathbf{V} \equiv [\sigma_i\ \sigma_j\ \rho_{ij}]$ denoting the invertible N x N variance-covariance matrix. For simplicity we assume that the rate of return from the risk-free technology is common to all countries, equal to rdt over the period [t, $t + dt$].

Following Obstfeld (1994), we make the important assumption that resources invested in one type of technology can be freely transformed into another type of technology. This implies that there will be no changes in the relative prices of assets when the economies are opened up to free trade. Accordingly, economic integration does not change any country's (initial) wealth. It turns out that this assumption greatly simplifies the welfare analysis.

With financial integration, households get access to several risky assets. Let **a**, ***dz***, **I**, and $\mathbf{w}_i$ all be N x 1 vectors. The jth element is α_j in the first vector and dz_j in the second, while the third vector is the identity vector. The last one is the vector of country i portfolio weights of risky assets, meaning that the jth entry is country i's demand for the risky asset in country j. Wealth dynamics can now be written as

$$dW_{i,t} = \mathbf{w}'_{i,t}\left(\mathbf{a} - r\mathbf{I}\right)W_{i,t}dt + \mathbf{w}'_{i,t}\mathbf{V}W_{i,t}\boldsymbol{dz}_t + \left(rW_{i,t} - c_{i,t}\right)dt, \quad \forall i. \tag{19}$$

At the time of financial integration, the representative household in each country maximizes their intertemporal objective (2), subject to the evolution equations for habit and wealth, (5) and (19), and given their wealth endowment when integration occurs. Following the same steps as Merton (1971) we find that the equation of optimality for country i is:

$$\underset{\{c_{i,t},\mathbf{w}_{i,t}\}}{Max}\left\{\tfrac{(c_i - x_i)^{1-\gamma_i}}{1-\gamma_i} - J_i\delta_i + \tfrac{\partial J_i}{\partial W_i}\left[\mathbf{w}'_i(\mathbf{a} - r\mathbf{I})W_i - c_i + rW_i\right] + \tfrac{\partial J_i}{\partial x_i}\beta_i(c_i - x_i) + \tfrac{1}{2}\tfrac{\partial^2 J_i}{\partial W_i^2}(\mathbf{w}'_i\mathbf{V}\mathbf{w}_i)W_i^2\right\} = 0.$$

First-order conditions are:

$$c_{i,t} = x_{i,t} + \left(W_{i,t} - \frac{x_{i,t}}{r}\right)\mu_i^* \qquad \forall i,$$

where $\mu_i^* \equiv \frac{r}{(\beta_i + r)\gamma_i}\left[\delta_i - (1-\gamma_i)\left(r + (\mathbf{a} - r\mathbf{I})'\mathbf{V}^{-1}(\mathbf{a} - r\mathbf{I})\right)\right]$, and

$$\mathbf{w}_{i,t} = \frac{\mathbf{V}^{-1}(\mathbf{a} - r\mathbf{I})}{\gamma_i}\left(1 - \frac{x_{i,t}}{rW_{i,t}}\right) \quad \forall i. \tag{20}$$

These equations are analogue to (7) and (8) in the closed economy, two-asset case, with the difference that (20) is an N x 1 vector. Absent time interdependence in the preferences, the demand for risky assets would be equal to $\mathbf{V}^{-1}(\mathbf{a} - r\mathbf{I})/\gamma_i$ and the consumption function would be $c_{i,t} = W_{i,t}\eta_i^*$ where $\eta_i^* \equiv \mu_i^*(\beta_i + r)/r$.

The fraction of wealth invested in risky assets by country i at time t is identified by the scalar $\mathbf{I}'\mathbf{V}^{-1}\left(\mathbf{a} - r\mathbf{I}\right)\frac{1}{\gamma_i}\left(1 - \frac{x_{i,t}}{rW_{i,t}}\right)$. To find the weight of each risky asset in the asset demand vector of country i we divide equation (20) by this expression, obtaining the following N x 1 weight vector:

$$\mathbf{q} \equiv \frac{\mathbf{V}^{-1}(\mathbf{a} - r\mathbf{I})}{\mathbf{I}'\mathbf{V}^{-1}(\mathbf{a} - r\mathbf{I})}. \tag{21}$$

This expression means that the mutual-fund theorem derived by Merton (1971) can be extended to the habit formation model: Every household wish to hold the same mutual fund of risky assets, independent of preferences and nationality. By implication, it also means that households will invest in the same mutual fund as with time separable preferences. Equation (20) shows that the representative households will invest a smaller *fraction* out of wealth in the mutual fund if habit persistence is relevant, while equation (21) tells us that the *composition* of the fund will be identical to the time separable case. Moreover, this composition will be constant since (21) is time independent. As with time separable preferences (Obstfeld, 1994), we can thus proceed by studying one single global risky asset with mean return $\alpha^* = \mathbf{q}'\mathbf{a}$ and variance $\sigma^{2*} = \mathbf{q}'\mathbf{V}\mathbf{q}$.

It is not difficult to show that in country i the fraction of wealth invested in this risky asset is

$$\omega^*_{i,t} = \lambda^*_i \left(1 - \frac{x_{i,t}}{rW_{i,t}}\right),$$

where $\lambda^*_i \equiv \frac{\alpha^* - r}{\gamma_i (\sigma^*)^2}$. We assume that $0 \le \lambda^*_i \le 1$ for at least one i to ensure that there is some positive demand for the risk-free technology after the N autarkic economies open up to free asset trade. Thus, the relevant world interest rate is equal to r. Taking this modification into account, we can follow Obstfeld (1994) to describe the equilibrium with free asset trade. We let $L \le N$ risky production technologies remain in operation after trade is opened,[8] available in the quantities $K_1, K_2, \ldots, K_L$. Letting $\mathbf{a}$, $\mathbf{V}$ and $\mathbf{q}$ now referring to the L-dimensional subvectors and -matrix for mean returns, variance/covariance of returns and mutual fund weights, respectively, global equilibrium satisfies the conditions:

$$\frac{K_i}{\sum_{i=1}^{L} K_i} = \mathrm{q}_i \quad \text{for all } i = 1, \ldots, L$$

$$\sum_{i=1}^{L} K_i = \sum_{i=1}^{N} \lambda^*_i \left(W_i - \frac{x_i}{r}\right),$$

where q_i refers to the ith element of $\mathbf{q}$. With time-separable preferences, the last of these conditions would be $\sum_{i=1}^{L} K_i = \sum_{i=1}^{N} \lambda^*_i W_i$. The equilibrium conditions thus confirm that the

[8] In general investors wish to go short in some of the countries' risky assets. This is not possible in the aggregate, so the associated production will shut down. The remaining L risky assets make up the 'global market portfolio', composed as specified by (26). For further explanation, see Obstfeld (1994), p. 1317.

global mutual fund demand will be lower if consumers are characterized by habit formation in consumption.

3.2 Consumption growth and volatility

We are now ready to analyze consumption growth and growth volatility with free asset trade. From equation (12) and the discussion in the preceding subsection, it follows that the mean consumption growth rate in the financially integrated equilibrium is given by

$$g_i^* = E\left[s_i^*\right]\left(k_i^* + \beta_i\right), \tag{22}$$

in country i. Here, $k_i^* \equiv \frac{r-\delta_i}{\gamma_i} + \frac{(1+\gamma_i)(\alpha^* - r)^2}{2\left(\gamma_i\sigma^*\right)^2}$ and $E[s_i^*]$ is the mean surplus consumption ratio prevailing in country i under financial integration. Other things equal, nations with a low mean surplus consumption will experience slower consumption growth than nations where the surplus consumption ratio is higher.

Comparing (12) and (22), we see that financial integration affects consumption growth through both k and the mean surplus consumption ratio. Obstfeld (1994) demonstrate that k (the mean growth rate with time separable preferences) is unambiguously higher under integration compared to financial autarky. With habit persistence, the change in the mean surplus consumption ratio also affects the growth rate. In a previous version of this paper, we have argued that $E[s_i]$ is decreasing in σ and increasing in α based on numerical simulations. Thus, we can assert that $E[s_i] \leq E[s_i^*]$ in countries where $\alpha_i \leq \alpha^*$ and $\sigma_i \geq \sigma^*$. In the cases where $\alpha_i \geq \alpha^*$, $\sigma_i \geq \sigma^*$ and $\alpha_i \leq \alpha^*$, $\sigma_i \leq \sigma^*$, no such simple argument can be used and analytical solutions are not attainable. However, the increase in k that follows upon financial integration is qualitatively similar to a pure increase in α or a decrease in σ. We therefore conjecture that the effect from financial integration on $E[s_i]$ is similar to such shifts, so that the mean surplus consumption ratio increases.

Given that our conjecture is correct (this is supported by the calibration exercise in section 4), the effects on $E[s_i]$ and k_i in equation (22) both contribute to increased growth of international asset trade. The intuition is the same as in the time separable model of Obstfeld (1994): The opportunity to diversify idiosyncratic risk induces a shift in resources from technologies with (relatively) low return and low risk to riskier, high-return technologies.

The variance of the consumption growth rate in country i, given financial integration, can be written as

$$(\sigma^*_{c,i})^2 = (\lambda^*_i\sigma^*)^2 \int_0^1 s_i^2 \pi_{s_i}(s_i) ds_i \qquad (23)$$

compared to $(\lambda_i^*\sigma^*)^2$ with time separable preferences. The integral in (23) is larger with financial integration if the mean surplus consumption ratio is larger. In order to see what happens to the term $(\lambda_i\sigma_i)^2$ we rewrite the expression for k as

$$k_i = \tfrac{r-\delta_i}{\gamma_i} + \tfrac{1}{2}(1+\gamma_i)(\lambda_i\sigma_i)^2,$$

by using the definition of λ. Since k increases due to asset trade, so does $(\lambda_i\sigma_i)^2$. Thus, in our model setup, financial integration implies a more volatile consumption growth path than financial autarky. The case of time separable preferences illustrates this clearly. Increased opportunities to diversify could very well reduce the risk associated with holdings of risky assets (σ), but at the same time it would induce a portfolio shift towards risky assets so that λ increases. In this model, the portfolio shift will dominate. Correspondingly, the consumption growth volatility will increase. Although the model is very simple, this illustrates that it could be misleading to associate increased opportunities to share risk internationally with smoother consumption paths. We believe that this is an important point that has been ignored in earlier literature.[9]

3.3 The gains from international risk sharing

Turning to the welfare effects of financial integration, we first note that trade in financial assets affects welfare through its effect on consumption growth and volatility. We compare the present value of the welfare gains in economies with and without intertemporal dependence. A convenient measure is equivalent variation, i.e. the percentage increase in wealth in autarky that makes the households equally well off as with financial integration.

In the economy with time separable utility we wish to find EV_i, where EV_i is implicitly defined by

$$J_i[W_{i,t}(1+EV_i);\, k_i] = J_i^*[W_{i,t};\, k_i^*]. \qquad (24)$$

In this expression, J_i and k_i denote lifetime utility measured at time t (the point in time when integration occurs) and the mean growth rate in autarky. The same quantities with financial integration are J_i^* and k_i^*. By substituting from equation (18) into (24), it is easy to show that

[9] There exists a rather large literature that estimates the welfare gains from financial integration with *exogenous* growth rates (see van Wincoop, 1999 for a survey). These models imply smoother consumption paths upon integration, and this is their source of the welfare gain. Our model illustrate that within an *endogenous* growth framework, one cannot necessarily associate financial integration with smoother consumption paths.

$$EV_i = \left[\frac{2\delta_i - (1-\gamma_i)(k_i + r)}{2\delta_i - (1-\gamma_i)(k_i^* + r)} \right]^{\gamma_i / 1-\gamma_i} - 1. \tag{25}$$

The first term on the right hand-side of (25) will always be > 1, confirming the positive welfare effect due to financial integration.

With habit formation, the equivalent variation measure is implicitly defined as

$$J_i \left\{ \left[W_{i,t}(1 + EV_{i,t}^H), x_{i,t} \right]; k_i \right\} = J_i^* \left[(W_{i,t}, x_{i,t}); k_i^* \right],$$

where k_i must be interpreted as a parameter which is positively affected by financial integration. Substitution from equation (17) into the expression immediately above gives us

$$EV_{i,t}^H = \left\{ \left[\frac{2\delta_i - (1-\gamma_i)(k_i + r)}{2\delta_i - (1-\gamma_i)(k_i^* + r)} \right]^{\gamma_i / 1-\gamma_i} - 1 \right\} \left(1 - \frac{x_{i,t}}{rW_{i,t}} \right). \tag{26}$$

By the first equality in equation (9), the last parenthesis in (26) is equal to $\gamma_i/R_{i,t}$. Hence, equations (25) and (26) give us a simple relationship between the welfare gain with and without habit persistence:

$$EV_{i,t}^H = EV_i \left(\frac{\gamma_i}{R_{i,t}} \right). \tag{27}$$

When risk-aversion is close to its lower bound γ_i (a large surplus consumption ratio), households respond to the asset trade possibility in the same manner as with time separable preferences. Thus, the welfare gain will be equal in the two cases. When risk-aversion is very high, the optimal allocation of resources is the autarky-allocation. In this case, the opportunity to trade in financial assets does not change welfare. In intermediate cases, the welfare gain is positive, but smaller than with time separable preferences.

According to (27), the welfare gain is lower if asset trade liberalization occurs in 'bad times'; i.e. when consumption is close to the habit level and risk-aversion is high. This seems counterintuitive; shouldn't international diversification be especially beneficial to agents who dislike risk? Not necessarily. If risk-aversion is high households dislike fluctuations to a large extent, and would not be willing to reallocate their portfolios towards risky assets in any significant degree. Thus, they will continue to have much of their portfolios invested in the risk-free asset. Accordingly, consumption growth and volatility would differ little from the autarky case, and, as we saw above, the welfare effect will be small.

Yet another way to see this is to observe that in the asset demand function $\omega_{i,t} = \lambda_i\gamma_i/R_{i,t}$ [equation (10)], the size of λ_i shifts to λ_i^* when asset trade becomes possible. By utilizing the derivative $\partial\omega_{i,t}/\partial\lambda_i = \gamma_i/R_{i,t} \leq 1$ in (27),

$$EV_{i,t}^{H} = EV_i\left(\frac{\partial\omega_{i,t}}{\partial\lambda_i}\right),$$

it is easy to see that the magnitude of the welfare gain is related to the portfolio shift. When the optimal reallocation is small, the welfare gain is small.[10]

4. A quantitative exploration

In this section, we will illustrate how the habit-formation model works by calibrating it to a two-country world, using stock market data for Western Europe and North America. The choice of regions is inspired by Dumas and Uppal (2001), who "…estimate welfare gains as they would be approximately when one integrates western Europe and northern America" (p. 290). As opposed to Dumas and Uppal, we will base our calibration on actual stock market data for these two regions.

We assume that these regions are imperfectly financially integrated and that stock market returns are a useful proxy for returns associated with the risky technology in the individual region. Together with the other parameters of the model, the stock market data allow us to generate consumption growth rates and variances in the habit formation model. These numbers provide the basis for calculating the theoretical welfare and growth gains due to perfect financial integration, and allow us to compare the gains to the corresponding ones in the model with time separable preferences.

The illustration is also similar to the calibrations in Obstfeld (1994). He considers time separable non-expected utility preferences. A drawback with that setup is that one must assume somewhat unrealistic parameter values to cope with the equity premium and risk-free rate puzzles. As mentioned in the introduction to this paper, and as will be shown below, habit formation models can be quite successful in explaining these puzzles. Hence, we believe that the numerical example given below is a worthwhile supplement to Obstfeld's analysis.

4.1 Data and calibration

The annual return and variance on the Morgan Stanley Capital International Europe and North America stock market indices are used as proxies for the average return and

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[10] This hinges on the assumption that the real risk-free interest rate is equal under free trade and autarky. If the risk-free interest rate rises, countries could experience higher growth rates without having to reallocate towards risky assets. This would probably enhance the welfare gains in the habit persistence model.

variance on risky capital.[11] The indices are in US-dollar, include reinvested dividends and ignore taxation. The index values we use cover the year-end quotes over the period 1969 - 98. Nominal returns are deflated by the US consumer price inflation to calculate the average annual real returns in dollars. Morgan Stanley provided us the data on the stock indices and the US consumer price index were collected from EcoWin. Panel A of table 1 reports the mean, standard deviations and correlation of risky capital dollar returns in the two regions.

As a proxy for the risk-free interest rate, we use $r = 0.02$. This roughly corresponds to the international t-bills returns reported in Campbell (1999) and - together with the stock market returns reported in table 1 - it yields considerable equity premiums.

[Table 1 about here]

In panel B of table 1, we have used the Penn World Table, Mark 5.2, to calculate the mean and standard deviation of private per capita consumption growth in our two regions, over the period 1970 - 92.[12] Given the equity premiums, the behavioral parameters should be set so that the models match these numbers. This attempt, however, reveals the problem of the time separable model: Restricting attention to positive rates of time preferences, it is impossible to find a pair (δ, γ) that match the mean and standard deviation of the growth rates in table 1.[13] Hence, in the case of time separable preference we only match the mean growth rate g. We do this by setting γ equal to the values used in the habit model (see below), and then choose δ in the time separable model so that $k = g$.

In the habit formation model we set the time preference rate fairly low at $\delta = 0.005$, while γ and β are chosen to match the mean and standard deviation of the consumption growth rates. We allow both γ and β to vary across regions but, as mentioned above, initially hold γ fixed across models. The consequences of using different γ's across models are discussed in subsection 4.4. Table 2 reports the benchmark values of r, δ, γ and β.

[Table 2 about here]

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[11] The countries included in the Europe index are Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the UK. The North America index includes Canada and the US.

[12] An earlier version of the Penn World Table (PWT) is documented in Summers and Heston (1991). The consumption measure in PWT includes durable goods. The theory used in this paper implies that a consumption measure excluding these categories would be better, but comparable data are not available for all countries included in our stock indices.

[13] The strategy described here implies that γ should be chosen to match the standard deviation of the growth rate, $\sigma_c = \lambda\sigma$. From the definition of λ, this implies $\gamma = (\alpha - r)/(\sigma_c\sigma)$. The numbers for e.g. North America in table 1 then implies $\gamma = 16.7$. Now, δ should be set so that the time separable model matches the mean growth rate k. Solving equation (13) for δ we would find $\delta = -20\%$ for North America. The number for Western Europe is similar.

The implied values of γ reported in table 2 seems reasonable, as does the derived values for δ in the time separable model. Finally, the implied values of β in the habit formation model are in line with the values considered 'likely' by Ryder and Heal (1973) (see also footnote 4 above).

4.2 Risk-taking and saving in the pre-integration equilibrium

Based on the above parameter values, we can compute the mean consumption growth rate and it's variance in each country by numerical integration in equations (12) and (16). Table 3 reports these estimates.

It is also of interest to compute the implied mean values of R, ω and c/W. The mean value of R is derived by Constantinides (1990) (see p. 528):

$$E[R] = \gamma\left[\left(1+\tfrac{\mu}{r}\right)\tfrac{\beta}{k-\lambda^2\sigma^2}\right]. \tag{28}$$

The results in Constantinides are also helpful to find $E[\omega]$ and $E[c/W]$. He derives the steady state distribution of the stochastic variable $y \equiv (1-s)/s$. This distribution can be used together with equation (10) to show that the mean fraction invested in the risky asset is

$$E[\omega] = \int_0^{\lambda} \omega\pi_{\omega}(\omega)d\omega = \lambda\int_0^{\infty}\left(1+\tfrac{\mu}{r}y\right)^{-1}\pi_y(y)dy, \tag{29}$$

where $\pi_{\omega}(\omega)$ and $\pi_y(y)$ are density functions, with $\pi_y(y) = \mathrm{M}y^{-2k/\lambda^2\sigma^2}\mathrm{e}^{-2\beta/y\lambda^2\sigma^2}, 0 \le y < \infty$. Given equation (11), we can apply the same procedure to derive the mean consumption/wealth ratio:

$$E[\tfrac{c}{W}] = \int_{\mu}^{r} \tfrac{c}{W}\pi_{\frac{c}{W}}(\tfrac{c}{W})d\left(\tfrac{c}{W}\right) = \int_0^{\infty}\left(\tfrac{\mu-r}{1+\frac{\mu}{r}y}+r\right)\pi_y(y)dy. \tag{30}$$

$E[R]$ can be calculated by plugging the relevant numbers from tables 1 and 2 into (28), while $E[\omega]$ and $E[c/W]$ can be computed numerically from equations (29) and (30), respectively. Table 3 reports these estimates. For the sake of comparison, all values in table 3 are also given for the time separable case.[14]

[Table 3 about here]

The first second row of table 3 demonstrates that the time separable model overestimates growth volatility when comparing to the numbers in table 1. This is of course just the inverse mirror of the equity premium puzzle; it is impossible to reconcile the large

[14] As a reminder, time separable preferences imply: $g = k$, $\sigma_c = \lambda\sigma$, $E[s] = 1$, $E[R] = \gamma$, $E[\omega] = \lambda$ and $E[c/W] = \eta$.

equity premiums and smooth consumption paths reported in table 1 without a much higher γ (and hence risk-aversion) than the ones that match the mean growth rates, given positive values of δ.[15] In the habit formation model, we have an extra parameter to play with (β) allowing us to replicate both the mean and the variance of the growth rates.

As seen in row 4 the habit formation model generates fairly high mean risk-aversion in both regions. Some researchers would argue that a risk-aversion between 20 and 30 is implausibly large. It *would* be undesirable in the time separable model since it would lead to counterfactual predictions for consumption growth. This is not a problem with habit persistence though and, as argued by Campbell and Cochrane (1999, p. 245), high risk-aversion seems inescapable in representative-agent models that are consistent with the equity premium facts.

Due to higher risk-aversion, we see from row 5 in table 3 that risk-taking is lower with habit formation. We notice that the habit model implies higher mean risk-taking in WE than in NA, despite a larger average risk-aversion in Europe and a fairly similar risk-return trade off in the two regions (see table 1). This is not inconsistent in the habit formation model. To see why, suppose that we were considering two regions i and j with exactly the same risk-return trade off ($\alpha_i = \alpha_j$ and $\sigma_i = \sigma_j$), but where $E[R_i] > E[R_j]$. By using equation (10), we can then show that mean risk-taking will be higher in region i if $E[1/R_i] > E[1/R_j]$, which of course is perfectly possible even though $E[R_i] > E[R_j]$.

The last row in table 3 shows that savings are higher with habit formation. This explains why the models generate equal mean growth rates, despite much higher risk-taking with time separable preferences. Higher (precautionary) savings for WE compared to NA, also helps explain why Europe has a smoother consumption path, despite higher risk-taking.

4.3 Financially integrated equilibrium

Given the asset return moments reported in table 1, we can use equation (21) to calculate the portfolio shares in the two-region mutual fund that would prevail after financial integration. Remember that this portfolio composition is constant and independent of national preferences. We obtain

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[15] Experiments with higher values of risk-aversion and time separable preferences would also bump into the risk-free rate puzzle of P. Weil (1989). By (8) and (16), the constant steady state growth rate with time separable preferences may be written as $k = \frac{r-\delta}{\gamma} + \frac{1}{2}(1+\gamma)\sigma_c^2$. Solving for r, we obtain $r = \delta + \gamma k - \frac{1}{2}(1+\gamma)\sigma_c^2$. Forcing k and σ^2_c equal to, e.g., the NA numbers in panel B of table 3 and maintaining our assumption on δ, γ would have to be less than one to obtain any reasonable size of the real risk-free interest rate. A $\gamma = 5$ would for example imply $r \approx 10.9$ %.

$$\mathbf{q} = \begin{bmatrix} 0.68 \\ 0.32 \end{bmatrix}.$$

Both North Americans and Western Europeans invest 68 % of their risky asset portfolio in North American capital. This is due to the somewhat larger return variance for European capital, see table 1.

The mean and standard deviation of the annual return of this portfolio is reported in table 4. Together with the earlier parameter assumptions, this is sufficient to compute the mean and standard deviation of the annual per capita consumption growth under financial integration, with and without habit persistence in consumption. These numbers are also reported in table 4.

[Table 4 about here]

Independent of model, both regions experience an increase in mean consumption growth. They also experience an increase in growth variability (σ_c) regardless of intertemporal dependence in preferences. The increase in both mean growth and variability is largest for WE in both models. The reason can be seen in second row from below. While North Americans would increase risk-taking only slightly upon integration, the Western European investors carry substantially more risk under integration than under 'autarky'. This increase in risk-taking spurs both mean growth and growth-variability.

The last row in table 4 shows that while saving increases slightly with habit formation (it is not noticeable until the fifth decimal for NA), it decreases in the time separable model. To forces determine the effect on optimal saving: First, the investment opportunity set is less risky under integration, contributing to lower savings. Second, the increase in risk-taking feeds back to the savings decision, contributing to more saving. In the habit-formation model the last effect dominates, while the opposite is true with time separable preferences.

Finally, we notice that mean risk-aversion ($E[R]$) in the habit model falls upon integration for both NA and WE, but the effect is largest in the latter case. The intuition is that Western Europeans view the improvement in the investment opportunity set as more substantial than North Americans, and this leads to a bigger fall in risk-aversion.

The welfare gain from international financial integration is equal to the constant EV, defined in (25), with time separable preferences. In the habit formation model, the gain is time varying; it is larger the higher is s (i.e. the lower is R) at time of integration. Here, we report the mean, or expected, welfare gain with habit formation, $E(EV^H)$. Using equations (10) and (27) it is easy to show that

$$E\left[EV_{i,t}^{H}\right]=EV_{i}E\left[\frac{\gamma_i}{R_{i,t}}\right]=EV_{i}\frac{1}{\lambda_i}E\left[\omega_{i,t}\right],$$

where $E[\omega_{i,t}]$ can be obtained from (29). Notice that both λ_i and $E[\omega_{i,t}]$ in the latter expression refers to their pre-integration values, and that EV_i is calculated with the (δ,γ) values used in the habit model.

Table 5 reports the welfare gains from financial integration. Three features of these numbers are worth commenting. First, the expected gain is larger for WE than for NA, regardless of model. Again, this reflects that the Europeans experience a more significant improvement in the investment opportunity set.

Second, the expected gains are lower with habit formation regardless of region. As discussed in section 3, this will always be the case if we use the same preference parameters (except β) cross models. Here, we have used a higher value for δ in the time separable case to match the mean growth rates for both models. It is possible to show that the welfare gain is decreasing in δ. Hence our exercise could in principle yield high gains from trade with habit formation. Table 5 show that this is not the case, however. The expected gains with habit formation are about 40-50% lower than the corresponding gains with time separable preferences.

The final point to be made from table 5 is that the reported gains with habit formation are substantially lower than what is reported in Obstfeld (1994) and in the benchmark calibration of Dumas and Uppal (2001). As discussed earlier, habit persistence in itself is one reason for the reduction in welfare gains. A second reason is that our data risky capital returns are more highly correlated across regions than the data used by Obstfeld and Dumas-Uppal.

Still, the gains from trade in financial assets are substantial also with habit formation. The gain for WE with habit formation is, for instance, 3-6 times larger than the typical gains reported by van Wincoop (1999) for models with exogenous growth rates. Hence, possible endogenous growth effects may be very important in evaluating possible gains from asset trade, also with habit formation.

4.4 Discussion

The former subsection demonstrated that habit formation gives lower gains from financial integration than a time separable model when both models are calibrated to match actual mean growth rates, holding γ fixed across models. Alternative calibration strategies would allow γ to vary cross models. In what follows we will discuss two alternatives for γ in the time separable model: (a) fix γ to match the standard deviations of growth in table 1, or (b) set γ in the time separable case equal to mean risk aversion with habit formation.

It is possible to show that the welfare gain from integration is decreasing in γ in both models. Since alternatives (a) and (b) both imply that γ in the time separable model should be increased from the benchmark values in table 2, this means that the *maximum* welfare gain becomes higher in the habit model. We believe it is more interesting to compare *expected* gains though.

Alternative (a) above implies that we set $\gamma = 16.7$ and 19 for NA and WE, respectively. Then, the time separable model would match the standard deviations of growth rates reported in table1, but would predict much to low mean growth rates. The gains from integration would fall to $EV = 0.9$ % for NA and $EV = 3.0$ % for WE. In both cases, these gains are *lower* than the expected gains with habit formation (compare with table 5).

Alternative (c) implies that we set $\gamma = 21.6$ and 28.2 for North Americans and Western Europeans, respectively. This would lower the welfare gain further to 0.7 % and 2.1 % for the two regions. Notice however that in this case, the time separable model completely misses both the mean and variability of the growth rates reported in table 1.

van Wincoop (1994) showed that with exogenous growth rates, the gains from international risk sharing is higher with habit formation than in a time separable model (p. 194). The benchmark calibration above shows that this result may very well be overturned when integration also affects growth rates. A possible interpretation is that in our model, households have to 'pay' for higher mean growth under integration by accepting that growth variability also increases. Since, in our benchmark, habit-forming households are more risk averse than their counterparts with time separable preferences, the former view increases growth variability as a higher price to pay for higher mean growth. In van Wincoop's model integration decreases growth variability (while mean growth rates are unaffected), and this is more valuable for households with habit formation.

5. Conclusions and discussion

This paper has explored the growth and welfare consequences from international asset trade, under the assumption of habit persistence in consumption. In our linear-technology model, financial integration will spur both mean consumption growth and the variance of the growth rate. These qualitative results replicate the model with time separable preferences. More importantly, the welfare gain from asset trade is lower with habit-forming households, despite higher risk-aversion. The benchmark calibration in section 4 show that the gains in the case of habit formation are about 50-60 % of the gains with time separable preferences. The analysis confirms that a setup with habit-persistence is better capable of explaining the large equity premium/ low risk-free interest rates observed in international data.

The result of lower gains from trade with habit formation hinges partly on the assumption of a common, global risk-free technology and that there are some investment in this technology. Without these assumptions, the risk-free real interest rate would change upon integration, and this would have a different effect with habit formation than with time separable preferences. Potentially, our ranking of welfare gains in the two cases could be overturned.

Even though the gains from integration in our model are lower with habit persistence, the empirical application of the model illustrates that they could be substantial. The reported welfare gains should be interpreted with a bit of caution, however. Two potential problems stem from the no-adjustment-costs constant-returns-to-scale production technologies. The assumption of no adjustment costs is likely to bias the welfare estimates upwards. Obstfeld (1994) presents some rough calculations which indicate that capital adjustment costs could be important: Assume that the current annual welfare gain converges towards the long run gains in table 5 at an instantaneous rate of κ % per year. Then, the actual capitalized gain amounts to a fraction $[\kappa/(r+\kappa)]$ of the numbers presented in the tables. Assuming, as Obstfeld, an annual rate of convergence of 2.2 %, a common annual risk-free interest rate of 2 % implies welfare gains of approximately 48 % of the gains in the respective tables.

On the other hand, and perhaps more importantly, the assumption on constant returns can bias the reported gains downwards. Constant returns imply that the expected returns on the risky assets are constant over time, so the time-varying risk aversion in our model is transferred solely into time-varying portfolio shares. If the distribution of asset returns were endogenous, we would have that expected returns would be higher in 'bad times' (when s is low and R high) since households would demand higher returns when risk aversion is high. Accordingly, risky assets would not be as unattractive when R is high as our model suggests. With endogenous asset returns, it is thus possible that our model understates the investors reallocation towards risky assets and hence also growth and welfare effects of financial integration. This issue deserves further research, but abandoning the constant returns assumption would make the model very difficult to solve.

Anyway, we believe that this paper has demonstrated the following general point: When habit-formation is introduced the growth/stability trade-off is tilted in favor of stability, and so possible growth effects from financial integration become less important.

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TABLE 1: STOCK MARKET RETURNS, 1970-98, AND CONSUMPTION GROWTH, 1970-92.

A. Mean (α), standard deviation (σ) and correlation (ρ) of annual risky returns.

	N America	**W Europe**
α	7.3 %	7.7 %
σ	15.9 %	18.7 %
ρ	0.732	

B. Annual mean growth rate (g) and standard deviation (σ_c) of actual consumption.

	N America	**W Europe**
g	1.8 %	2.4 %
σ_c	2.0 %	1.6 %

TABLE 2: IMPLIED AND ASSUMED PARAMETERS

	Habit formation model		Time separable model	
	N America	**W Europe**	**N America**	**W Europe**
r	2 %	2 %	2 %	2 %
δ	0.5 %	0.5 %	2.0 %	2.2 %
γ	3.9	2.6	3.9	2.6
β	0.06	0.16	0	0

TABLE 3:CHARATERISTICS OF THE PRE-INTEGRATION EQUILIBRIUM.

	Habit formation model		Time separable model	
	N America	**W Europe**	**N America**	**W Europe**
g	1.8 %	2.4 %	1.8 %	2.4 %
σ_c	2.0 %	1.6 %	8.5 %	11.7 %
$E[s]$	0.22	0.12	1	1
$E[R]$	21.6	28.2	3.9	2.6
$E[\omega]$	0.24	0.30	0.54	0.63
$E[c/W]$	0.0140	0.0118	0.0305	0.0317

Note: All parameter values are as reported in tables 1 and 2.

TABLE 4: CHARACTERISTICS OF THE EQUILIBRIUM UNDER FINANCIAL INTEGRATION.

	Habit formation model		Time separable model	
	N America	**W Europe**	**N America**	**W Europe**
α^*	7.4 %	7.4 %	7.4 %	7.4 %
σ^*	15.7 %	15.7 %	15.7 %	15.7 %
g^*	1.9 %	2.9 %	1.9 %	3.1 %
σ_c^*	2.2 %	2.1 %	8.8 %	13.2 %
$E[s^*]$	0.23	0.15	1	1
$E[R^*]$	20.7	24.2	3.9	2.6
$E[\omega^*]$	0.26	0.42	0.56	0.84
$E[(c/W)^*]$	0.0140	0.0117	0.0312	0.0347

Note: All parameter values are as reported in tables 1 and 2.

TABLE 5: EXPECTED WELFARE GAINS FROM FINANCIAL INTEGRATION - EVALUATED BY EQUIVALENT VARIATION.

	N America	**W Europe**
EV_i	3.0 %	15.8 %
$E[EV_i^H]$	1.7 %	9.9 %