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Abstract

We examine the real option implicit in countries' decisions of whether to join a monetary union and calibrate our theoretical model for the core ASEAN/AFTA group of Indonesia, Malaysia, Philippines, Singapore and Thailand. None of the countries would be prepared to join a monetary union amongst them at present, and most have low to negligible probabilities of ever wanting to do so.

1 Introduction

With the European Monetary Union in operation since 1999, focus has shifted to other areas of the world, particularly Asia, to examine whether similar ventures might be viable or desirable there.[1] Policymakers are generally concerned about inflation performance, possibly because a time inconsistency problem in monetary policymaking can cause an undesirable inflation bias to persist.[2] If the future evolution of such inflation preferences is uncertain, the decision to join a monetary union represents a real option due to policymakers' reluctance to commit to a largely irreversible move that could later prove less advantageous than initially thought.[3]

[1] See e.g. Eichengreen/Bayoumi (1999).
[2] See e.g. Barro/Gordon (1983).
[3] See e.g. Dixit/Pindyck (1994).

In this paper we extend and apply the theoretical model of Strobel (2002, 2005) in examining this real option implicit in countries' decisions of whether to join a monetary union when the costs of later leaving it again are considered prohibitively high and there is uncertainty over the future benefits of such a move. We calibrate our model for the core ASEAN/AFTA countries of Indonesia, Malaysia, Philippines, Singapore and Thailand by proxying policymakers' stochastic inflation biases with unemployment rates, derive the proxied trigger values of relative inflation bias parameters for different time horizons and contrast them with the corresponding actual ratios for 2003, our reference period. We find that none of the countries considered would be prepared to join a monetary union amongst them at present, most of them have low to negligible probabilities of ever wanting to do so, whilst also not expecting that event to occur in finite time. Those countries thus appear too heterogenous and variable at the moment to make formation of a monetary union much of a realistic prospect in the near future.

Section 2 now presents the model; the results of our calibration exercise are reported in section 3, and section 4 concludes the paper.

2 The model

Policymakers in countries c and the potential wider union u are assumed to be exclusively concerned with inflation performance; they face instantaneous loss rates $l_{it} = \xi_{it}$, where exogenous inflation biases $\xi_{it} \geq 0$ follow geometric Brownian motions[4]

$$d\xi_{it} = \sigma_i \xi_{it} dz_{it} \ , \ i = c, u \tag{1}$$

with $\sigma_i > 0$, $dz_{it} = \varepsilon_{it}\sqrt{dt}$ are increments of Wiener processes with $\varepsilon_{it} \sim \text{NID}(0,1)$, and $E_t(dz_{ct}dz_{ut}) = \rho dt$ with ρ the coefficient of correlation between the processes z_{it} (and $-1 \leq \rho < 1$).

The expected present discounted value of losses associated with inflation performance is then[5]

[4] Similar frameworks are used in Strobel (2002, 2005).

[5] See e.g. Dixit (1993, eq. (2.7)).

$$L_{it} = E_t \int_t^{\infty} l_{i\tau} e^{-\mu(\tau - t)} d\tau = \frac{\xi_{it}}{\mu} \tag{2}$$

where $\mu > 0$ is the (possibly subjective) discount rate.

The decision of a country c on whether or not to join the wider monetary union u then involves solving the Bellman equation for the optimal stopping problem

$$F(L_c, L_u) = \max \left\{ L_c - L_u \ , \ \frac{1}{\mu dt} E_t[dF(L_c, L_u)] \right\} \tag{3}$$

where $F(L_c, L_u)$ is the value to country c of the option of joining the wider monetary union u , and $L_c - L_u$ is the expected discounted benefit of such a move when any other cost/benefits are abstracted from.[6] Note that this implicitly assumes that joining a monetary union is an irreversible process, so that the costs of possibly later leaving it again are considered prohibitively high. We can then obtain

Proposition 1 *Country c will want to exercise the option of joining the wider monetary union u if*

$$\begin{aligned} \frac{\xi_u}{\xi_c} &\leq \frac{\xi_u^*}{\xi_c^*} = \frac{\beta_1 - 1}{\beta_1} \\ \text{where } \beta_1 &= \frac{1}{2}\left(1 + \frac{1}{\sqrt{1 - \frac{8\mu^3}{8\mu^3 + {\sigma_c}^2 - 2\rho\sigma_c\sigma_u + {\sigma_u}^2}}}\right) \end{aligned}$$

Otherwise it will keep the option unexercised, with expected time and probability of future exercise of

$$T\left(\frac{\xi_u}{\xi_c}\right) = \begin{cases} \infty & \text{if } {\sigma_u}^2 \leq {\sigma_c}^2 \\ \frac{\ln\left(\frac{\xi_u^*}{\xi_c^*}\right) - \ln\left(\frac{\xi_u}{\xi_c}\right)}{\frac{1}{2}({\sigma_c}^2 - {\sigma_u}^2)} & \text{if } {\sigma_u}^2 > {\sigma_c}^2 \end{cases}$$

$$P\left(\frac{\xi_u}{\xi_c}\right) = \begin{cases} 1 & \text{if } {\sigma_u}^2 \geq {\sigma_c}^2 \\ \exp\left(\frac{\left(\ln\left(\frac{\xi_u^*}{\xi_c^*}\right) - \ln\left(\frac{\xi_u}{\xi_c}\right)\right)({\sigma_c}^2 - {\sigma_u}^2)}{{\sigma_c}^2 - 2\rho\sigma_c\sigma_u + {\sigma_u}^2}\right) & \text{if } {\sigma_u}^2 < {\sigma_c}^2 \end{cases}$$

[6] We drop time subscripts for ease of notation.

Proof. See Appendix. ■

Country c perceives exercise of the option of joining the wider monetary union u as desirable only when the current value of relative inflation bias parameters $\frac{\xi_u}{\xi_c}$ is less than (or equal to) its trigger value $\frac{\xi_u^*}{\xi_c^*}$; intuitively, the higher a country's inflation bias relative to the potential wider union's, the more it stands to gain from giving up its monetary independence. While $\frac{\xi_u}{\xi_c} > \frac{\xi_u^*}{\xi_c^*}$ applies, on the other hand, country c strictly prefers to leave the option of monetary integration unexercised and remains outside the wider union for the time being; in this case, we can further derive the expected time and probability of its potential future exercise of that option.

3 A simple calibration

We proceed to calibrate the model in Section 2 for the core ASEAN/AFTA countries of Indonesia, Malaysia, Philippines, Singapore and Thailand by proxying national policymakers' inherent inflation biases ξ_c with unemployment rates; this reflects the familiar rationale for the potential benefits of surprise inflation based on the expectational Phillips curve.[7]

Using annual data for the period 1986-2003 drawn from the Asian Development Bank's Key Indicators 2004,[8] we calculate the required moments from the respective transformed series $\ln(\frac{x_t}{x_{t-1}})$ to reflect our distributional assumption of eq. (1); these are reported in Table 1. The potential monetary union's inflation bias ξ_u is for these purposes constructed as the simple arithmetic mean of the constituent countries' proxied values; this mimics a bargaining outcome over the union's monetary policy where individual member countries have equal votes.

The proxied trigger values of relative inflation bias parameters $\frac{\xi_u^*}{\xi_c^*}$, from Proposition 1, are then computed for time horizons of 10 and 25 years by applying discount rates of 12.5% and 5.5%, respectively, to allow for varying degrees of policymakers' myopia.[9] These results, together with the proxied

[7] See e.g. Barro/Gordon (1983).

[8] Available at www.adb.org/statistics .

[9] Given our infinite horizon framework, these approximate the application of a (real)

	StDev	Corr w/ All	Corr w/ MST
Indonesia	0.205	0.574	
Malaysia	0.143	0.728	0.706
Philippines	0.105	0.588	
Singapore	0.259	0.621	0.763
Thailand	0.511	0.683	0.790
All	0.129	1.000	
MST	0.206		1.000

Source: Asian Development Bank (ADB) - Key Indicators 2004

Table 1: Standard deviations & correlation coefficients

	Ratio w/ All (03)	Trigger ratio w/ All	
		10 year	25 year
Indonesia	0.620	0.109	0.011
Malaysia	1.630	0.228	0.031
Philippines	0.583	0.209	0.027
Singapore	1.253	0.078	0.008
Thailand	3.824	0.020	0.002

Source: Asian Development Bank (ADB) - Key Indicators 2004

Table 2: Ratios & trigger ratios with All

values for the relative inflation bias parameters $\frac{\xi_u}{\xi_c}$ for 2003, our reference period, are presented in Tables 2 and 3 both for a potential monetary union comprising all five countries (All) as well as a narrower one (MST) consisting only of Malaysia, Singapore and Thailand (the low-unemployment group in our reference period). Table 4 then gives the expected times and probabilities, from the second part of Proposition 1, of the option of monetary integration potentially being exercised at some point in the future for those different constellations.

From Table 2 we observe that none of the countries considered would be prepared to join a monetary union comprising the whole group at present, irrespective of time horizon. Table 4 further indicates that, apart from the Philippines which has expected joining times hundreds of years above the

discount rate of 2.5% over those finite time horizons.

	Ratio w/ MST (03)	Trigger ratio w/MST	
		10 year	25 year
Malaysia	0.909	0.137	0.015
Singapore	0.699	0.110	0.012
Thailand	2.132	0.027	0.002

Source: Asian Development Bank (ADB) - Key Indicators 2004

Table 3: Ratios & trigger ratios with MST

	All				MST			
	10yrs		25yrs		10yrs		25yrs	
	Prob	Time	Prob	Time	Prob	Time	Prob	Time
Indonesia	0.210	inf	0.028	inf				
Malaysia	0.486	inf	0.233	inf	1.000	171.6	1.000	370.9
Philippines	1.000	359.4	1.000	1076.6				
Singapore	0.036	inf	0.002	inf	0.196	inf	0.027	inf
Thailand	0.001	inf	0.000	inf	0.001	inf	0.000	inf

Source: Asian Development Bank (ADB) - Key Indicators 2004

Table 4: Probabilities & expected times

time horizon, none of them ever expects wanting to do so. Malaysia and Indonesia have otherwise the highest probabilities of ever wanting to join a monetary union comprising the whole group, while those probabilities are negligible for Singapore and Thailand, particularly for the longer time horizon where uncertainty leads to significantly more cautious behavior.

We observe similar results for the sub-group of Malaysia, Singapore and Thailand: Table 3 shows that none of them would be prepared to join a narrow monetary union between them at present either, irrespective of time horizon. While Malaysia expects future joining dates that lie only very substantially above the time horizons considered, Singapore and Thailand never expect wanting to join at all, and it is then only Singapore for the 10 year horizon that has a non-negligible probability of ever wanting to be part of such a union.

To sum up the results of our simple calibrations: the five ASEAN/AFTA

countries considered appear at present too heterogenous and variable to make formation of a monetary union amongst them much of a realistic prospect in the near future, as the value of waiting associated with such a major regime shift proves rather substantial for the criteria considered.

4 Conclusion

We examined the real option implicit in countries' decisions of whether to join a monetary union and calibrated our theoretical model for the core ASEAN/AFTA group of Indonesia, Malaysia, Philippines, Singapore and Thailand. We found that none of the countries considered would be prepared to join a monetary union amongst them at present and that most of them have low to negligible probabilities of ever wanting to do so. Those countries thus appear too heterogenous and variable at the moment to make formation of a monetary union much of a realistic prospect in the near future.

Appendix

Proof. *(Proposition 1)* For country c , not joining the wider monetary union u for a further instant dt is optimal in the continuation region of the optimal stopping problem eq. (3), giving the relevant Bellman equation as

$$\mu F(L_c, L_u) = \frac{1}{dt} E_t[dF(L_c, L_u)] \tag{4}$$

Applying Ito's Lemma to eq. (4) and noting that the value function $F(L_c, L_u)$ should be homogeneous of degree 1,[10] so that $F(L_c, L_u) = L_u f(\Gamma)$ where $\Gamma \equiv \frac{L_c}{L_u}$,[11] we obtain

$$\frac{1}{2}\left({\sigma_c}^2 - 2\,\rho\,\sigma_c\,\sigma_u + {\sigma_u}^2\right)\Gamma^2\,f''(\Gamma) - \mu^3\,f(\Gamma) = 0 \tag{5}$$

[10] This adopts the solution strategy in Dixit and Pindyck (1994, p. 210).

[11] Thus, $\Gamma = \frac{\xi_c}{\xi_u}$ from eq. (2).

as the differential equation that characterizes the evolution of $f(\Gamma)$ in that region.

We solve equation (5) by standard methods, using the value-matching and smooth-pasting conditions $f(\Gamma^*) = \Gamma^* - 1$ and $\frac{\partial f(\Gamma^*)}{\partial \Gamma} = 1$, plus the boundary condition $f(0) = 0$,[12] and thus obtain

$$\Gamma^* = \frac{\beta_1}{\beta_1 - 1} > 1$$

$$\text{where } \beta_1 = \frac{1}{2}\left(1 + \frac{1}{\sqrt{1 - \frac{8\,\mu^3}{8\,\mu^3 + {\sigma_c}^2 - 2\,\rho\,\sigma_c\,\sigma_u + {\sigma_u}^2}}}\right) > 1$$

as the critical (trigger) value Γ^*. From the definition of Γ it then follows that $\frac{\xi_u^*}{\xi_c^*} = (\Gamma^*)^{-1}$ is the trigger value of relative inflation bias parameters $\frac{\xi_u}{\xi_c}$ separating the region in (ξ_c, ξ_u) space where country c's option of monetary integration remains unexercised (i.e. for $\frac{\xi_u}{\xi_c} > \frac{\xi_u^*}{\xi_c^*}$) from the one where immediate exercise of that option is perceived as optimal (i.e. for $\frac{\xi_u}{\xi_c} \leq \frac{\xi_u^*}{\xi_c^*}$).

The expected time $T\left(\frac{\xi_u}{\xi_c}\right)$ and probability $P\left(\frac{\xi_u}{\xi_c}\right)$ for the process $\frac{\xi_u}{\xi_c}$ to reach the barrier $\frac{\xi_u^*}{\xi_c^*}$ from any position within the continuation region (thus triggering country c's desired move towards monetary integration) is then derived using standard properties of Brownian motion.[13] ■

[12] The geometric Brownian motion Γ has an absorbing barrier at zero.

[13] See e.g. Dixit (1993, eq. (6.5) and (6.10)).

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