



# HOARDING OF INTERNATIONAL RESERVES: MRS MACHLUP'S WARDROBE AND THE JONESES

## Abstract

Motivated by the observed international reserve hoarding behavior in the post-1997 crisis period, we explore the Mrs Machlup's wardrobe hypothesis and the related keeping up with the Joneses argument. It is conceived that, in addition to psychological reasons, holding a relatively high level of international reserves reduces the vulnerability to speculative attacks and promotes growth. A stylized model is constructed to illustrate this type of hoarding behavior. The relevance of the keeping up with the Joneses effect is examined using a few plausible empirical specifications and data from 10 East Asian economies. Panel-based regression results are suggestive of the presence of the Joneses effect; especially in the post-1997 crisis period. Individual economy estimation results, however, show that the Joneses effect varies across economies.

JEL Code: F3, F4.

Keywords: demand for international reserves, excessive international reserve accumulation, speculative attack, keeping up with the Joneses.

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## 1. Introduction

The 1997 financial crisis in East Asia underscores the importance of capital account variability and the role of flow reversal on triggering off a crisis. Economies in the crisis-inflicted region appear to have adjusted their policy behavior and have sharply boosted their international reserves in the aftermath of the crisis. For instance, China, Japan, Korea, Malaysia and Taiwan; the economies that are commonly mentioned in the recent discussion/debate of the extraordinary and puzzling accumulation of international reserves in the new millennium, see their international reserves increased by, respectively, 388%, 135%, 119%, 138% and 137% between 2000 and 2005.<sup>1</sup>

The steep increase in international reserves definitely helps these economies to deter speculative attacks. Nonetheless, the dramatic jumps in international reserve holdings raise concerns in both policy and academic circles. In general, it is perceived that some of these economies are holding international reserves at a level that is difficult to be rationalized by conventional factors. For instance, one traditional indicator of international reserve adequacy is the reserves-to-imports ratio and the rule of thumb is to maintain international reserves worth, say, three months of imports.

Again, consider China, Japan, Korea, Malaysia and Taiwan – their holdings of international reserves are much higher than the three-month benchmark. Specifically, at the end of 2005, the international reserves held by these economies cover, respectively, 14.93, 19.33, 9.66, 7.36, and 16.65 months of imports. While excessive international reserves offer some benefits, they carry substantial negative implications for both domestic economies and global imbalances, and thus, can be a serious threat to the stability of the world economy.

Existing theories offer a few reasons for holding international reserves. One common explanation is the precautionary demand motivated by trade financing considerations.<sup>2</sup> The recent literature has extended the precautionary motive and considers accumulation of international reserves a policy to avoid crisis-induced output losses and investment contractions.<sup>3</sup>

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<sup>1</sup> Based on data from the April 2006 IFS data CD.

<sup>2</sup> See, for example, Grubel (1971) for a survey of the pre-1970 studies. Flood and Marion (2002) review the theory and provide some recent empirical evidence. Genberg *et al.* (2005) discuss some specifics related to Asia.

<sup>3</sup> See, for example, Aizenman *et al.* (forthcoming), Jeanne and Rancière (2006), and Lee (2004).

Conditions in the financial market are also deemed important determinants of the holding of international reserves. For instance, the popular Greenspan-Guidotti rule recommends that developing economies should hold international reserves to cover short-term external debts. In general, it is advisable to cover the one year amortized value of various types of liabilities over a wide range of possible outcome.<sup>4</sup> Apparently, these factors do not fully explain the surge in international reserves witnessed in the new millennium.

In a series of articles Dooley, Folkerts-Landau and Garber (2005) argue that the large hoarding of international reserves by East Asian economies is a natural consequence of the presence of a revived Bretton Woods system in the region. In essence, these economies adopt the mercantilist approach, pursue the export-led growth strategy followed by the post-war Europe and Japan, and, hence, accumulate international reserves. According to their view, international reserve accumulation is a by-product of the development strategy that promotes exports with an undervalued currency. Aizenman and Lee (2005), however, find that even though the mercantilist motive is confirmed by the data, it has little economic significance in explaining the buildup of international reserves in the post-crisis era.

In the current study, we explore an idea advanced by Machlup (1966) and assess the extent to which his idea is relevant for explaining the international reserve accumulation behavior of some East Asian economies. Fritz Machlup, after examining some measures of international reserves, argued that the observed holding patterns could not be explained by reasons offered “by either theorists or practitioners.” Instead, he suggested monetary authorities’ hoarding of international reserves can be driven by non-fundamental factors. Specifically, he used his wife’s *need* for dresses as a metaphor to exemplify the monetary authorities’ desire for more and more international reserves.

Apparently, the recent ascent in the holding of international reserves and some related official remarks lend credibility to the Mrs Machlup’s Wardrobe analogy. For instance, an official in the Korea’s central bank said “(T)here is no such thing as too much foreign international reserves.” On China’s international reserve holding, a Chinese official argued that

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<sup>4</sup> The rule follows from the former Federal Reserve Chairman Alan Greenspan’s comments on Pablo Guidotti’s insight on the role of external debts in 1999. See Greenspan (1999). Guidotti is a former Deputy Minister of Finance of Argentina. de Beaufort Wijnholds and Kapteyn (2001), on the other hand, argue that the domestic liability represented by money supply should also be considered.

there is “no unified benchmark on the appropriate amount of forex international reserve a country should hold in both theory and practice” and “it could not be said to be “excessive” or “deficient.”<sup>5</sup> The official statements usually point to the need of building up international reserves to fend off external shocks and speculative attacks but do not offer a target level based on fundamental considerations. Even with the anecdotal evidence, is it reasonable to assert that the insatiable appetite of central banks for international reserves is the sole reason for the recent buildup of international reserves?

We postulate that the international reserve accumulation process pertaining to the Mrs Machlup’s Wardrobe metaphor may serve some relevant economic purposes. It is quite non-controversial to state that, on the other things being equal basis, international reserves help absorb unexpected (external) shocks and smooth current and capital account imbalances. The crisis experience and the development after the crisis appear to be consistent with the notion of accumulating international reserves to forestall future speculative attacks. The question, of course, is how high the level of international reserves an economy has to hold?

On his wife’s dress need, Machlup (1966, p. 26) suggests that it depends “on the Joneses with whom she wishes to keep up.” That is, besides some fundamental considerations, the buildup of international reserves depends on the behavior of neighboring economies. Ignoring the question of why Mrs Machlup has to keep up with the Joneses for a moment, the (implicit) rivalry among economies may give raise to competitive hoarding mechanism that pushes the holding of international reserves to a level that is difficult to be explained by only traditional considerations.

Besides the pure psychological desire to feel good and not to be perceived as inferior, there are a few reasons why economies would like to keep up with their peers. Remarks by Feldstein (1999) and Fischer (1999), for example, offer some insight on the keeping up with the Joneses motivation. After the crisis, these two noted economists observed that economies with a higher level of international reserves survived the East Asian financial crisis better than those with a lower level. Thus, a level of international reserves that is relatively higher than your neighbors may diffuse the speculative pressure on your own economy and divert it to the neighboring economies and, hence, reduce the chance of bearing the full cost of an attack. In other words, when a financial crisis is brewing in the region, if two economies have similar

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<sup>5</sup> Day and Choi (2004) and Xinhua News Agency (2004).

economic fundamentals, the one with a higher level of international reserves is less likely to be attacked and more likely to survive the crisis.

Another reason for keeping up with the Joneses is that international reserves can have a positive impact on an economy's output prospects. If the level of international reserves is a barometer of financial health, an economy has an additional incentive to keeping up with the Joneses to position itself to compete for international capital and foreign direct investment, which tend to have a level of productivity proficiency higher than the domestic capital. For developing economies, the output effect of international reserves also arises from their ability to reduce costs of borrowing in the international capital market and provide needed liquidity when there is a reversal of capital flows. A relatively high level of international reserves will, thus, provide a catalyst for economic growth and enhance output prospects, which in turn will improve the market sentiment and, hence, reduce an economy's vulnerability to attack.

In the remaining part of the paper, we use a stylized model to illustrate the demand for international reserves when Mrs Machlup takes the Joneses into consideration. Specifically, we assume that an economy's vulnerability to speculative attacks depends on, among other things, international reserves held by other economies. The exercise also underscores the international reserve's feedback on output potential and the related Joneses effect. Further, we take the idea to the data from a group of East Asian economies and investigate whether these economies display the keeping up with the Joneses behavior.

## **2. International Reserve Hoarding and Keeping up with the Joneses**

In this section, we present a sequence of models to illustrate the demand for international reserves in the presence of keeping up with the Joneses due to a) the consideration of speculative attack, and b) the feedback effect of international reserves on output. The first model serves as a benchmark, the second one modifies the speculative attack probability to accommodate the notion of keeping up with the Joneses, and the third one introduces a positive output effect of international reserves.

A caveat is in order. The following discussion highlights two possible situations that lead to the keeping up with the Joneses effect. Similar to the implicit psychological motivation in Machlup (1966), any mechanisms that give rise to competitive hoarding behavior will generate the keeping up with the Joneses effect described in this and the next section.

## 2.1 The Benchmark Model

In this subsection, we derive the baseline demand for international reserves. The basic structure is essentially the model used by Aizenman *et al.* (forthcoming). A few simplifications were implemented to reduce the complexity of the model and highlight the issue we would like to analyze. For this reason, we refer interested readers to Aizenman *et al.* (forthcoming) for a more detailed description.

We consider a two-period model. In period one the economy has an output endowment  $Y_1$ . Without loss of generality, the initial endowment is normalized to 1; that is  $Y_1 = 1$ . The output in the second period  $Y_2$  is a random variable given by

$$Y_2 = \begin{cases} 1 + \delta & \text{with probability } 1 - p \\ 1 - \varepsilon & \text{with probability } p \end{cases}; \quad \delta, \varepsilon > 0 \text{ and } 0 < p < 1. \quad (1)$$

The random output shocks  $\delta$  and  $\varepsilon$  are not necessarily the same. The probability that the economy suffers from output losses due to a speculative attack is  $p$ . For simplicity, we ignore attacks that do not have any output implications.<sup>6</sup> For the benchmark model, we assume  $p$  is given by

$$p = \phi + \alpha \frac{B}{R}, \quad \alpha > 0, \quad (2)$$

where  $R$  and  $B$  are, respectively, the level of international reserve holding and the amount of foreign borrowing in period 1. In essence, (2) assumes the probability of suffering an attack that leads to an output loss is inversely related to the level of international reserves and directly proportional to the level of indebtedness.  $\alpha$  is a scale parameter to ensure that the output loss probability  $p$  stays within the legitimate region.  $\phi$  is a catch-all parameter representing other factors that affect the attack probability. We label the occurrence of  $1 + \delta$  a good state and that of  $1 - \varepsilon$  a bad state.

During the first period, given the output  $Y_1$ , the economy makes decisions regarding consumption ( $C_1$ ), international reserve accumulation ( $R$ ) and borrowing in the international capital market ( $B$ ), and is subject to the budget constraint

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<sup>6</sup> It means the probability  $(1 - p)$  includes these events: 1) no speculative attack; 2) a speculative attack has been neutralized or defended without output loss; 3) any other speculative attacks that do not induce an output drop. Also, we ignore output losses due to factors other than speculative attacks.

$$C_1 = 1 + B - R. \quad (3)$$

The international borrowing carries a contractual interest rate  $r$  and, thus, the required repayment in period 2 is  $(1+r)B$ .

Because of a possible default in the second period, the economy faces a credit ceiling that limits the amount it can borrow internationally. The credit ceiling can be determined as follows. In the case of default, we assume the international lender can confiscate a share of  $Y_2$ , denoted by  $\theta Y_2$ ;  $0 < \theta < 1$ , from the economy. However, the international lender does not have access to the economy's international reserves. If the repayment  $(1+r)B$  is larger than the penalty  $\theta Y_2$ , then the economy has an incentive to default. Thus, the international lender would determine the lending amount knowing that the repayment he is going to receive in period 2 is

$$S = \text{MIN}[(1+r)B; \theta Y_2], \quad (4)$$

where  $\text{MIN}[.,.]$  is the minimum operator. Let the (international) risk-free interest rate be  $r^*$ . It is assumed that  $r > r^*$ .<sup>7</sup> Under risk neutrality, the expected repayment is given by

$$E[S] = (1+r^*)B. \quad (5)$$

The credit ceiling,  $\bar{B}$ , faced by the economy is the level of debt that will lead to a default in both good and bad states. Thus, it is given by

$$\bar{B} = \frac{(1-p)\theta(1+\delta) + p \cdot \theta(1-\varepsilon)}{1+r^*} = \frac{\theta(1+\delta) - p\theta(\delta+\varepsilon)}{1+r^*}. \quad (6)$$

The credit ceiling is increasing with the positive production shock  $\delta$  and the ability to confiscate  $\theta$ , and is decreasing with the adverse production shock  $\varepsilon$ , the probability of an attack that leads to output losses  $p$ , and the risk free rate  $r^*$ .

Assuming a)  $(1+r)B \leq \theta(1+\delta)$ , b)  $(1+r)B > \theta(1-\varepsilon)$  with the probability  $q$ , and c) the international reserves earn an interest rate of  $r^*$ , the budget constraint for the second period is given by<sup>8</sup>

<sup>7</sup> The Appendix shows that the economy has to pay a premium in the international capital market; that is  $r > r^*$

<sup>8</sup> The economy defaults in the bad state if  $1 - \varepsilon - (1+r)B < (1-\theta)(1-\varepsilon)$ , which can be simplified to the condition  $(1+r)B > \theta(1-\varepsilon)$ . Thus,  $q$  is the default probability under the bad state and depends on the adverse output shock  $\varepsilon$ .

$$C_2 = \begin{cases} C_{2,g} = 1 + \delta - (1+r)B + (1+r^*)R & \text{with probability } 1-p \\ C_{2,b} = 1 - \varepsilon - (1+r)B + (1+r^*)R & \text{with probability } p \cdot (1-q), \\ C_{2,b,d} = (1-\theta)(1-\varepsilon) + (1+r^*)R & \text{with probability } p \cdot q \end{cases}, \quad (7)$$

where  $C_{2,g}$ ,  $C_{2,b}$ ,  $C_{2,b,d}$  are, respectively, the levels of consumption in period 2 when the economy is in the good state, in the bad state with no default, and in the bad state and defaulted.

The economy has to choose the levels of consumption  $C_1$  and  $C_2$  to maximize its representative consumer's expected utility, which is given by

$$U(.) = C_1 + \frac{1}{1+\rho} \left[ (1-p)C_{2,g} + p[(1-q)C_{2,b} + qC_{2,b,d}] \right], \quad (8)$$

where  $\rho$  is the discount rate and is assumed to be larger than the risk-free interest rate  $r^*$ . Taking the output loss probability (2) and the budget constraints (3) and (7) into consideration, the task is to maximize the expected utility  $U(.)$  subject to the conditions (2), (3), and (7). In solving the utility maximization problem, we should obtain the optimal levels of borrowing and international reserves along with the optimal consumption path.

To simplify the presentation, we follow Aizenman *et al.* (forthcoming) and assume that the economy has a discount rate high enough to set the borrowing at the ceiling level  $\bar{B}$ . When  $B = \bar{B}$ , the contractual (not the expected) repayment is

$$B(1+r)|_{B=\bar{B}} = \theta(1+\delta), \quad (9a)$$

and the expected utility  $U(.)$  can be written as

$$U(.)|_{B=\bar{B}} = (1+\bar{B}-R) + \frac{1}{1+\rho} \left\{ (1-\theta)(1+\delta) + (1+r^*)R - p(1-\theta)(\delta+\varepsilon) \right\}. \quad (9b)$$

Thus, the first order condition with respect to  $R$  is

$$1 - \frac{dB}{dR}|_{B=\bar{B}} = \frac{1}{1+\rho} \left[ (1+r^*) - (1-\theta)(\delta+\varepsilon) \frac{dp}{dR}|_{B=\bar{B}} \right], \quad (10)$$

which equates the marginal cost of increasing one unit of  $R$  in period one to the resulting (discounted) benefit obtained in period two.

Next, we derive  $\frac{dB}{dR}|_{B=\bar{B}}$  and  $\frac{dp}{dR}|_{B=\bar{B}}$  from (2) and (6) and substitute the results in (10) to obtain

$$\left[ (1+r^*)R + \alpha\theta(\delta+\varepsilon) \right]^2$$

$$= \frac{(\delta + \varepsilon)[(1 + r^*) + \theta(\rho - r^*)][\alpha\theta(1 + \delta) - \alpha\theta\phi(\delta + \varepsilon)]}{(\rho - r^*)}. \quad (11)$$

Thus, the optimal level of international reserves is

$$R_b = \left\{ \frac{(\delta + \varepsilon)[(1 + r^*) + \theta(\rho - r^*)][\alpha\theta(1 + \delta) - \alpha\theta\phi(\delta + \varepsilon)]}{(1 + r^*)^2(\rho - r^*)} \right\}^{1/2} - \frac{\alpha\theta(\delta + \varepsilon)}{1 + r^*}. \quad (12)$$

The subscript “b” indicates that the expression is going to be used as a benchmark for comparison. From (12), it can be verified that the hoarding of international reserves is a) positively related to  $(\delta + \varepsilon)$ , the benefit of not being attacked and  $\theta$ , the share of output being confiscated when it defaults, and b) negatively related to  $(\rho - r^*)$ , the opportunity cost and  $\phi$ , the catch-all parameter that determines the economy’s vulnerability. It is also noted that  $\bar{B}$  is positively related to  $R_b$  since  $\bar{B}$  is negatively related to  $p$  (equation (6)) and  $p$  is negatively related to  $R$  (equation (2)).

## 2.2 The Joneses

To capture the idea of “keeping up with the Joneses,” we modify the probability that the economy suffers an output-loss-causing attack to

$$p_J = \phi + \alpha \frac{B_J}{R_J} + \beta \frac{\tilde{R}_0}{R_J}, \quad \alpha, \beta > 0, \quad (13)$$

where the subscript “J” indicates the presence of the Joneses effect.  $\tilde{R}_0$  is the average of international reserves held by its peer group (the Joneses) at period 0.<sup>9</sup>

Equation (13) incorporates the effect of international reserves held by other economies. It captures the notion that, *ceteris paribus*, speculators tend to attack an economy with a relatively low level of international reserves, which are powerful ammunition against speculative attacks. In addition to its own level of international reserves, an economy has to be aware of its relative position among its peer group. Attacks can be triggered by self-fulfilling expectations that are not related to fundamentals and speculators will look for a victim that has a relatively (rather than an absolutely) high level of vulnerability. Lagged rather than current international reserves in other economies are considered because current information about other

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<sup>9</sup> Strictly speaking, the model is extended to a three-period model. However, the period 0 is added to accommodate  $\tilde{R}_0$  and it has no implications for other aspects of the model.

economies' international reserves is typically hard to obtain.<sup>10</sup> Indeed, Mrs Machlup's desire for dresses is likely to be instigated by seeing her contemporaries' collection.

With the output loss probability specified by (13) rather than (2), the demand for international reserves in the presence of the Joneses effect can be derived by maximizing the expected utility  $U(\cdot)$  in (8) subject to the conditions (13), (3), and (7). We follow a similar strategy and consider borrowing at the ceiling. In this case, the credit ceiling is given by

$$\bar{B}_J = \frac{\theta(1+\delta) - p_J\theta(\delta+\varepsilon)}{1+r^*}, \quad (14a)$$

and the corresponding first order condition is given by

$$1 - \frac{dB}{dR} \Big|_{B=\bar{B}_J} = \frac{1}{1+\rho} \left[ (1+r^*) - (1-\theta)(\delta+\varepsilon) \frac{dp}{dR} \Big|_{B=\bar{B}_J} \right], \quad (14b)$$

where the subscript "J" is used to indicate the presence of the Joneses effect. Thus, it can be shown that

$$\begin{aligned} & \left[ (1+r^*)R_J + \alpha\theta(\delta+\varepsilon) \right]^2 \\ &= \frac{(\delta+\varepsilon) \left[ (1+r^*) + \theta(\rho-r^*) \right] \left[ \alpha\theta(1+\delta) - \alpha\theta\phi(\delta+\varepsilon) + (1+r^*)\beta\tilde{R}_0 \right]}{(\rho-r^*)}, \end{aligned} \quad (15)$$

and the optimal level of international reserves is

$$\begin{aligned} R_J &= \left\{ \frac{(\delta+\varepsilon) \left[ (1+r^*) + \theta(\rho-r^*) \right] \left[ \alpha\theta(1+\delta) - \alpha\theta\phi(\delta+\varepsilon) + (1+r^*)\beta\tilde{R}_0 \right]}{(1+r^*)^2(\rho-r^*)} \right\}^{1/2} \\ &\quad - \frac{\alpha\theta(\delta+\varepsilon)}{1+r^*}. \end{aligned} \quad (16)$$

Similar to  $R_b$  in (12), the demand for international reserves in the presence of the Joneses increases with  $(\delta+\varepsilon)$  and  $\theta$ , and decreases with  $(\rho-r^*)$  and  $\phi$ . Through their impact on the attack probability, the international reserves held by others have a positive implication for an economy's own hoarding of international reserves. Further, an economy's level of international reserves is positively related to its sensitivity to the Joneses effect as measured by  $\beta$ .

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<sup>10</sup> Abel (1990) studies a model in which an individual's current consumption depends on the lagged aggregated consumption. He suggested the use of the phrase "catching up with the Joneses" instead of "keeping up with the Joneses" to reflect the dependence on lagged consumption. Nonetheless, we stay with Machlup's original wording for consistence.

Comparing (12) and (16), it can be seen that the positive term  $(1+r^*)\beta\tilde{R}_0$  is the only difference between  $R_b$  and  $R_j$ . Thus,  $R_j$  is larger than  $R_b$  – the demand for international reserves is higher in the presence of the Joneses effect, *ceteris paribus*. An economy's optimal level of international reserves is higher than the one justified by fundamentals alone when its probability of being attacked is adversely affected by international reserves held by other economies. Given the possibility of being victimized and suffering output losses from speculative attacks with a relatively low level of international reserves, an economy's rational response is to incorporate others' behavior into its own decision making process.

### 2.3 Feedback on Output Outlook

In this subsection, we modify the model in subsection 2.2 and incorporate the output effect of international reserves. It is shown that economies will be encouraged to accumulate international reserves if the accumulation can improve their output outlook.

Recently, Aizenman and Lee (2005) adapt a model by Diamond and Dybvig (1983) to show that international reserves enhance output performance by providing the necessary liquidity to avert the damaging output effect of capital flight/sudden stop shocks.

Intuitively, holding of international reserves can affect output via a few channels. For instance, international reserves can smooth trade imbalances and, hence consumption. For most developing economies, a high level of international reserves helps reduce the premium they have to pay for borrowing in the global financial market. Both a smooth consumption stream and a low borrowing cost are good for economic growth. Further, the level of international reserves can serve as an indicator of financial health and stability of an economy. Thus, a high level of international reserves helps developing economies to attract foreign direct investment, which tends to boost domestic growth.

To illustrate the implication for international reserve demand in the current framework, we refine our specification of output shocks in the second period (equation (1)) to

$$\delta = \delta^* + R_{J,F} / \tilde{R}_0,$$

and

$$\varepsilon = \varepsilon^* - R_{J,F} / \tilde{R}_0. \tag{17}$$

To facilitate comparison, the expression  $R_{J,F} / \tilde{R}_0$  is introduced to the output shocks to capture the output effect of international reserves. The subscript “ $J,F$ ” signifies both the Joneses effect and the feedback on output are under consideration. We assume the effects of international reserves on output are the same in both the good and bad states to simply derivation.<sup>11</sup> The presence of  $\tilde{R}_0$  suggests the output effect depends on the relative rather than the absolute holding level of international reserves. For instance, in making a foreign direct investment decision, an entrepreneur would consider if the financial health of an economy is better than the alternatives. Thus, if the level of international reserves is an indicator, then the relative level will determine which economy will get the investment, *ceteris paribus*. If the positive output effect of international reserves outweighs the output loss induced by speculative attack; that is  $\varepsilon^* < R_{J,F} / \tilde{R}_0$ , we have the result described by Aizenman and Lee (2005).

With the modified output  $Y_2$  given by (17), the budget constraint (7) is modified to

$$C_2 = \begin{cases} C_{2,g} = 1 + \delta - (1+r)B_{J,F} + (1+r^*)R_{J,F} & \text{with probability } 1 - p_{J,F} \\ C_{2,b} = 1 - \varepsilon - (1+r)B_{J,F} + (1+r^*)R_{J,F} & \text{with probability } p_{J,F} \cdot (1 - q_{J,F}) \\ C_{2,b,d} = (1-\theta)(1-\varepsilon) + (1+r^*)R_{J,F} & \text{with probability } p_{J,F} \cdot q_{J,F} \end{cases} \quad (18)$$

In this case, the credit ceiling  $\bar{B}_{J,F}$  explicitly depends on international reserves;

$$\bar{B}_{J,F} = \frac{\theta(1 + \delta^* + R_{J,F} / \tilde{R}_0) - p_{J,F}\theta(\delta^* + \varepsilon^*)}{1 + r^*}.$$

We solve the utility maximization problem by maximizing  $U(\cdot)$  in (8) subject to (13), (3), (18), and (17). That is, we incorporate the Joneses factor induced by both the speculative attack consideration and the output effect of international reserves into the utility maximization problem.

The expression of the optimal demand for international reserves,  $R_{J,F}$ , is given by

$$\frac{(\delta^* + \varepsilon^*)[(1+r^*) + \theta(\rho - r^*)][\alpha\theta(1 + \delta^* + R_{J,F} / \tilde{R}_0) - \alpha\theta\phi(\delta^* + \varepsilon^*) + (1+r^*)\beta\tilde{R}_0]}{(\rho - r^*)[(1+r^*)R_{J,F} + \alpha\theta(\delta^* + \varepsilon^*)]^2}$$

<sup>11</sup> In the Appendix, we employ the Aizenman and Lee (2005) apparatus and show that output levels in both good and bad states are increasing functions of the (relative) holding of international reserves. To simplify the presentation we work with (17).

$$= \frac{1}{(1+r^*)} - \frac{[(1+r^*) + \theta(\rho - r^*)]R_{J,F}}{(1+r^*)R_{J,F} + \alpha\theta(\delta^* + \varepsilon^*)}. \quad (19)$$

The optimal  $R_{J,F}$  can be derived from (19), which is a quadratic equation in  $R_{J,F}$ . Instead of solving for a rather complex expression, we just note that the optimal  $R_{J,F}$  is larger than the  $R_J$  term given in (16). The result is quite intuitive. For instance,  $R_J$  is increasing in the output shocks  $\delta$  and  $-\varepsilon$ , which are larger than their counterparts  $\delta^*$  and  $-\varepsilon^*$ .<sup>12</sup> In a word, the beneficial output effect strengthens the Joneses effect and effectuates a high level of international reserves. While most discussions focus on cushioning effects during an attack, the hoarding of international reserves can be motivated by their (indirect) contributions to economic performance during non-crisis periods. The output effect can be a significant factor for developing economies in designing their policies.

### 3. Empirical Evidence

In the previous section, we used a theoretical structure to elaborate Machlup's (1966) contention about international reserve demand behavior. Specifically, we outlined a model to interpret the Mrs Machlup's Wardrobe and keeping up with the Joneses argument and to illustrate the dependence of an economy's international reserve behavior on other economies' holdings of international reserves. Admittedly, the models in Section 2 are quite stylized. They are meant to demonstrate the keeping up with the Joneses effect, but not necessarily the exact relationship between international reserves held by an economy and by its neighboring economies. In the current section, we present some evidence on the relevance of the Mrs Machlup's Wardrobe and keeping up with the Joneses argument.

Annual data from 10 Asian economies, namely China, India, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, Taiwan, and Thailand are used to assess the keeping up with the Joneses effect. These economies are located in the 1997 crisis-inflicted region. They are either adversely affected by the crisis and/or cited in the recent debate on excessive accumulation of international reserves. The sample period is from 1980 to 2004.

The demand for international reserves is investigated using the regression equations

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<sup>12</sup> The alternative representations of  $R_b$ ,  $R_J$ , and  $R_{J,F}$  given in the Appendix offer another way to compare these three variables.

$$Y_{it} = c + X_{it}' \alpha + \varepsilon_{it}, \quad (20)$$

$$Y_{it} = c + X_{it}' \alpha + \delta J_{i,t-1} + \varepsilon_{it}, \text{ and} \quad (21)$$

$$Y_{it} = c + X_{it}' \alpha + \delta J_{i,t-1} + \psi I(t-1 > 97) * J_{i,t-1} + \varepsilon_{it}, \quad (22)$$

where  $i$  and  $t$  are the economy and time indexes,  $Y_{it}$  is the ratio of international reserves to gross domestic product (GDP),  $X_{it}$  is the vector containing the traditional economic variables used in the literature to explain the demand for international reserves, and  $J_{i,t-1}$  is the variable capturing the keeping up with the Joneses effect. Henceforth, we label  $J_{i,t-1}$  “the Joneses” variable for brevity and define it later.  $I(\cdot)$  is the indicator function. The interactive Joneses term  $I(t-1 > 97) * J_{i,t-1}$  is included to investigate if there is a change in the Joneses effect in the post-1997 crisis period. The joint estimation of  $\delta$  and  $\psi$  helps determine if there is a change in the behavior of demand for international reserves after the 1997 East Asian financial crisis and if the Joneses effect only shows up after the crisis.

Equation (20) is a canonical specification and includes economic variables commonly considered in empirical studies of demand for international reserves.<sup>13</sup> We normalize international reserves with GDP to facilitate comparison across economies of different sizes. The variables in the  $X_{it}$  vector are a) the *per capita* GDP in logarithms, b) the average propensity to import given by the imports to GDP ratio, c) the exchange rate volatility measured by the standard deviation of monthly exchange rate data, d) the volatility of international reserve holding measured by the standard deviation of monthly data on international reserves, and e) the financial openness variable given by the sum of absolute values of capital inflow and outflow divided by GDP. The Taiwanese data were retrieved from the Central Bank of China (Taiwan) website and all other data were retrieved from the World Bank WDI and the IMF databases.

The Joneses effect is assessed using equations (21) and (22). The key issue is how to define the Joneses variable. We do not have a foolproof way to handle it because we do not have information on who are the Joneses. As a first attempt, we consider the Joneses variable  $J_{it}$  defined by

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<sup>13</sup> Some recent studies on the empirical international reserve demand behavior include Lane and Burke (2001), de Beaufort Wijnholds and Kapteyn (2001), Flood and Marion (2002), Aizenman and Marion (2003). Earlier studies are reviewed in, for example, Grubel (1971).

$$J_{it} = \sum_{k \neq i} Y_{kt} . \quad (23)$$

That is, all the other economies in the sample are the Joneses. Later, we consider a few alternative definitions of the Joneses variable.

Table 1: Demand for international reserves and the Joneses effect

	Model (20)	Model (21)	Model (22)
lngdppc	0.1437*** (9.65)	0.0605*** (3.10)	0.0682*** (3.63)
mp	0.4374 (1.08)	0.0015 (0.04)	-0.0164 (-0.41)
F_open	0.2105*** (4.86)	0.1704*** (4.20)	0.1564*** (4.01)
E_vol	0.0000** (2.00)	0.0000** (2.22)	0.0000 (1.49)
R_vol	0.0025*** (3.72)	0.0014** (2.14)	0.0010 (1.60)
Joneses		0.0681*** (6.27)	0.0298** (2.21)
I>97*Joneses			0.0242*** (4.45)
constant	-0.9794*** (-8.73)	-0.4236*** (-3.03)	-0.4206*** (-3.14)
Adj. R-squares	0.5561	0.6211	0.6535
Observations	235	228	228

Note: The table reports the results of estimating models (20) to (22) in the text using the panel data technique. “lngdppc” is log *per capita* GDP, “mp” is propensity to import, “F\_open” is financial openness, “E\_vol” is exchange volatility, and “R\_vol” is international reserve volatility. “Joneses” is the Joneses variable defined by equation (23) in the text. “I>97\*Joneses” is the interactive Joneses variable  $I(t-1>97) * J_{i,t-1}$ . T-statistics are in parentheses. “\*\*\*” and “\*\*” denote significance at the 1% and 5% levels, respectively.

### 3.1 Panel Data Results

The results of estimating (20) to (22) using the panel data technique are presented in Table 1. Under specification (20), in the absence of Joneses variables, most of the traditional

factors in  $X_{it}$  are significant. The *per capita* output is a measure of the level of development and is significantly positive – a result similar to the one reported in Lane and Burke (2001). The import propensity is the average (rather than marginal) propensity. Thus, it is a proxy for trade openness and the degree of vulnerability to external shocks and has the expected positive coefficient (Frenkel, 1974).<sup>14</sup>

The effect of financial openness on the holding of international reserves is similar to the one of trade openness – a high level of openness increases an economy’s vulnerability to external shocks. Even though both openness variables have a positive coefficient estimate, only the financial openness estimate is statistically significant. A similar financial openness effect is reported in, for example, Flood and Marion (2002). Frenkel and Jovanovic (1981) illustrate the effect of international reserve volatility in a stochastic inventory control setting.<sup>15</sup> The estimation result is in accordance with the positive impact of international reserve volatility on hoarding of international reserves. Similarly, the international reserve holding is found to be negatively affected by exchange rate volatility.

Overall, these five variables explain the international reserve behavior quite well – in total they explain 56% of the variation in international reserve holdings of these 10 economies.

Estimation results pertaining to specifications (21) and (22) buttress the presence of keeping up with the Joneses effect among these East Asian economies between 1980 and 2004. Under specification (21), the coefficient estimate of the Joneses variable is highly significant with a value of 0.068. In addition to statistical significance, the Joneses effect is of practical relevance. According to the estimate, a dollar increase in the international reserves held by one economy will lead to an increase of about .6 dollar by the other nine “peer economies.” The inclusion of the Joneses variable lifts the adjusted R-squares from 56% to 62%. Compared with the results of (20), the coefficient estimates of the traditional explanatory variables are smaller and have a lower level of significance in the presence of the Joneses variable.

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<sup>14</sup> In contrast to Frenkel, Heller (1966) predicts a negative theoretical relation between propensity to import and the level of international reserves based on the argument that the higher the propensity to import ( $m$ ), the smaller marginal costs of balance of payments adjustment (i.e.,  $1/m$ ), and the weaker the demand for international reserves.

<sup>15</sup> A similar model, which is the stochastic version of the one developed by Baumol (1952) and Tobin (1956), is used by Frenkel and Jovanovic (1980) to model cash holding.

The interactive term  $I(t-1 > 97) * J_{i,t-1}$  in specification (22) is positively significant along side with the Joneses variable  $J_{i,t-1}$ . The Joneses effect is not unique to the post-1997 crisis period but it is stronger after the East Asian financial crisis. The inclusion of the interactive Joneses term nonetheless lowers the impact of the original Joneses variable. It also weakens the significance of the traditional explanatory variables with the exception of the *per capita* output. Indeed, with both the Joneses variable and its interactive term, the *per capita* output and the financial openness are the only two traditional explanatory variables that are significant at the 5% level.

The coefficient estimate of the interactive term is quite comparable to that of the Joneses variable – suggesting that the keeping up with the Joneses effect is amplified quite noticeably after the Asian financial crises. The two estimates indicate that, with a dollar increase in one economy's holding of international reserves, the other peer economies will boost their international reserves by slightly less than .3 dollar before the crisis but by slightly larger than .5 dollar after the crisis. The strengthening of the effect appears in accordance with the anecdotal evidence mentioned in the introduction. Apparently, the dramatic adverse effect of the crisis sways policymaker's behavior and makes them be more strategic in positioning their holdings of international reserves among their peers. An interesting observation is the presence of the keeping up with the Joneses effect even before the crisis.

One uncertainty is that we do not know, from these economies' point of view, who are their Joneses. Equation (23) implicitly asserts that all the economies in the sample are the Joneses. To check the robustness of the estimation results, we consider an alternative specification of the Joneses variable. Instead of trying all the possible combinations, we reckon the possibility that an economy may identify just a few representatives in the region as the Joneses. Such a strategy may be justified by monitoring costs and by the belief that the representative economies have timely information and have good assessment of the regional economic conditions.

Thus, to investigate the robustness of the results, we consider the Joneses variable comprises international reserve data from only China, Japan, Korea, and Taiwan; that is

$$J_{it} = \sum_{k=\text{China, Japan, Korea, and Taiwan}} Y_{kt} \quad (24)$$

These four are arguably the major economies in the region. For any one of these four economies, the Joneses variable is defined to be the sum of the other three economies' international reserves. The estimation results based on the alternative definition of the Joneses variable are presented in Table 2.

Table 2: Demand for international reserves with an alternative definition of the Joneses variable

	Model (21)	Model (22)
lngdppc	0.1107*** (6.72)	0.0905*** (5.82)
mp	0.0474 (1.15)	0.0068 (0.18)
F_open	0.0846** (2.57)	0.0598* (1.95)
E_vol	0.0000** (2.13)	0.0000 (1.36)
R_vol	0.0016** (2.40)	0.0009 (1.40)
Joneses_4	0.1173*** (6.10)	0.0372* (1.70)
I>97*Joneses_4		0.0946*** (6.25)
constant	-0.7671*** (-6.27)	-0.5593*** (-4.75)
Adj. R-squares	0.5867	0.6498
Observations	228	228

Note: The table reports the panel regression results of models (21) and (22) in the text. “lngdppc” is log *per capita* GDP, “mp” is propensity to import, “F\_open” is financial openness, “E\_vol” is exchange volatility, and “R\_vol” is international reserve volatility. “Joneses\_4” is the Joneses variable defined by equation (24) in the text.

“I>97\*Joneses\_4” is the interactive Joneses variable  $I(t-1>97) \cdot J_{i,t-1}$ . t-statistics are in parentheses. “\*\*\*”, “\*\*”, and “\*” denote significance at the 1%, 5% and 10% level, respectively.

Compared with Table 1, the Joneses effect based on the four-economy specification is stronger. For the whole sample estimation, the Joneses variable coefficient is 0.117 in Table 2

versus 0.068 in Table 1. Since only four economies in the sample contribute to the Joneses effect, the pattern of response to an increase in international reserves is slightly different from the one obtained from Table 1. Specifically, the response will be relatively strong in the first period and be relatively moderate in the subsequent periods. To gauge the magnitude of the Joneses effect in this setting, we consider the case in which one of the four Joneses economies increases its international reserves by one dollar. The increase of total international reserves in the first period is slightly over one dollar. In the second period, the total international reserves move up by a moderate amount of .4 dollar.

Apparently, the significance of the four-economy Joneses variable is mainly driven by its effect in the post-crisis period. The Joneses variable  $J_{i,t-1}$  is significant only at the 10% but not at the 5% level in the presence of the significant interaction term  $I(t-1 > 97) * J_{i,t-1}$ .

In terms of overall explanatory power, the two specifications with a four-economy Joneses variable have adjusted R-squares estimate slightly lower those reported in Table 1. Even though the pattern of the Joneses effect changes as we modify the way to construct the Joneses variable, the change appears to be a matter of magnitude rather than of the nature of the effect. Specifically, both Joneses variables indicate the Joneses effect is stronger in the post-crisis period.

### 3.2 *Economy-By-Economy Results*

The panel regression technique adopted in Tables 1 and 2 improves estimation efficiency by pooling data across economies. However, the technique restricts the economies to display same responses to explanatory variables. The restriction may not be appropriate for a diverse group of economies. An alternative approach is to use the data from individual economies to estimate the international reserve demand equations. Such an approach offers only 24 or less observations per economy but allows us to explore economy-specific behavior and its possible implications for the Joneses effect. Recognizing the small sample size we are working with, we report the estimation results for individual economies in Table 3.

The economy-by-economy results without the Joneses variable are presented in Table 3.a. It is evident that the coefficient estimates are heterogeneous across individual economies. There are both similarities and differences between these results and those from Model (20) reported in Table 1.

Table 3.a: Results from individual economies without the Joneses effect

	China	India	Indonesia	Japan	Korea	Malaysia	Philippines	Singapore	Taiwan	Thailand
Ingdppc	0.1151*** (3.69)	0.0161 (0.65)	0.0309 (1.02)	0.1344*** (3.00)	0.1184*** (5.15)	0.1246 (1.07)	-0.0515 (-0.65)	0.2902** (2.63)	-0.4402*** (-3.36)	0.1468*** (4.12)
mp	-0.5428* (-1.97)	0.9984*** (3.42)	0.5418* (1.94)	0.9556*** (3.78)	0.9602*** (4.32)	0.0685 (0.43)	0.4353*** (6.97)	-0.1026 (-0.99)	1.7498*** (3.74)	0.3930*** (3.94)
F_open	-0.1363 (-0.41)	-0.1487 (-0.53)	-1.3096*** (-2.90)	0.0803 (0.62)	-0.3103 (-1.65)	-0.1262 (-0.64)	0.1400*** (3.56)	-0.0764 (-1.10)	0.3525 (0.83)	0.2376** (1.97)
E_vol	-0.0253 (-0.35)	-0.0053 (-1.48)	0.0001** (2.78)	-0.0008 (-0.74)	-0.0004*** (-3.92)	-0.2740*** (-3.18)	-0.0093** (-2.51)	-0.5536 (-0.75)	-0.0136 (-0.45)	-0.0023 (-0.60)
R_vol	0.0046*** (5.43)	0.0106*** (6.22)	-0.0023 (-0.13)	0.0017*** (4.39)	0.0117*** (4.66)	0.0431*** (3.73)	-0.0110 (-0.63)	0.0338* (1.81)	0.0165** (2.97)	-0.0130** (-1.98)
constant	-0.5492*** (-3.43)	-0.1399 (-1.16)	-0.1707 (-0.99)	-1.4426*** (-3.01)	-1.2295*** (-5.04)	-0.8032 (-0.97)	0.2928 (0.55)	-1.8721 (-1.64)	3.7644*** (3.33)	-1.0589*** (-4.81)
Adj R-squares	0.9152	0.9176	0.8244	0.8008	0.9192	0.7958	0.8893	0.8346	0.8432	0.9465
Observations	23	24	24	25	25	24	25	25	15	25

Note: The table reports the results of estimating model (20) economy by economy. “Ingdppc” is log *per capita* GDP, “mp” is propensity to import, “F\_open” is financial openness, “E\_vol” is exchange volatility, and “R\_vol” is international reserve volatility. t-statistics are in parentheses. “\*\*\*”, “\*\*”, and “\*” denote significance at the 1%, 5% and 10% level, respectively.

Table 3.b: Results from individual economies with the Joneses effect

	China	India	Indonesia	Japan	Korea	Malaysia	Philippines	Singapore	Taiwan	Thailand
Ingdppc	0.1226*** (2.91)	0.0448 (0.69)	-0.0378 (-1.02)	-0.0150 (-0.37)	0.1379*** (3.07)	-0.0112 (-0.07)	-0.0647 (-0.74)	-0.0112 (-0.10)	-0.5494** (-2.78)	0.0994** (2.64)
mp	-0.4901 (-1.44)	0.7831* (1.74)	0.4269* (1.73)	0.8716*** (4.97)	0.9513*** (4.12)	0.1228 (0.73)	0.4054*** (3.52)	-0.2803*** (-2.95)	1.5215** (2.69)	0.1891 (1.71)
F_open	-0.1901 (-0.48)	-0.2066 (-0.61)	-0.6230 (-1.32)	0.0067 (0.08)	-0.4761** (-2.21)	-0.0081 (-0.04)	0.1348*** (3.44)	-0.0581 (-1.11)	0.1661 (0.33)	0.4562*** (3.61)
E_vol	-0.0336 (-0.42)	-0.0054 (-1.45)	0.0001*** (3.17)	0.0006 (0.76)	-0.0004*** (-3.6)	-0.1813* (-1.77)	-0.0075* (-1.74)	-0.1226 (-0.21)	-0.0095 (-0.30)	-0.0037 (-1.13)
R_vol	0.0046*** (5.14)	0.0110*** (5.39)	-0.0058 (-0.37)	0.0005 (1.44)	0.0114*** (4.26)	0.0401*** (3.49)	-0.0063 (-0.33)	0.0349** (2.49)	0.0146** (2.36)	-0.0128** (-2.27)
Joneses	-0.0101 (-0.28)	-0.0055 (-0.32)	0.0410** (2.63)	0.0619*** (5.21)	-0.0049 (-0.17)	0.0647 (1.63)	0.0073 (0.52)	0.1538*** (3.97)	0.0808 (0.75)	0.0576*** (3.15)
constant	-0.5820** (-2.87)	-0.2766 (-0.9)	0.1907 (0.94)	0.0035 (0.01)	-1.3804*** (-3.54)	0.1150 (0.11)	0.3743 (0.64)	1.0855 (0.97)	4.7485** (2.72)	-0.7645*** (-3.27)
Adj R-squares	0.9103	0.9142	0.8678	0.9193	0.9265	0.8094	0.8957	0.902	0.8353	0.9612
Observations	23	23	24	24	24	23	24	24	15	24

Note: The table reports the results of estimating model (21) economy by economy. “Ingdppc” is log *per capita* GDP, “mp” is propensity to import, “F\_open” is financial openness, “E\_vol” is exchange volatility, and “R\_vol” is international reserve volatility. “Joneses” is the Joneses variable defined by equation (23) in the text. t-statistics are in parentheses. “\*\*\*”, “\*\*”, and “\*” denote significance at the 1%, 5% and 10% level, respectively.

Table 3.c: Results for individual economies with period-specified Joneses effects

	China	India	Indonesia	Japan	Korea	Malaysia	Philippines	Singapore	Taiwan	Thailand
lngdppc	0.0902** (2.53)	-0.0198 (-0.37)	0.0389 (1.12)	-0.0176 (-0.42)	0.0437 (1.35)	-0.0756 (-0.5)	-0.1240* (-1.75)	-0.0050 (-0.04)	-0.8913*** (-3.96)	0.1692*** (6.25)
mp	-0.2494 (-0.87)	0.6319* (1.79)	0.2958 (1.57)	0.7775*** (3.56)	0.2596 (1.37)	0.1877 (1.15)	0.3196*** (3.40)	-0.2686** (-2.71)	1.3437** (2.84)	0.0408 (0.54)
F_open	-0.0822 (-0.26)	0.3899 (1.24)	-0.1483 (-0.39)	-0.0044 (-0.05)	-0.1095 (-0.74)	-0.1070 (-0.53)	0.0776** (2.21)	-0.0566 (-1.05)	0.1978 (0.48)	0.2949*** (3.47)
E_vol	-0.0369 (-0.57)	-0.0023 (-0.75)	0.0000** (2.32)	0.0004 (0.53)	-0.0002** (-2.49)	-0.1575 (-1.61)	-0.0062* (-1.81)	-0.1682 (-0.28)	0.1055 (1.81)	-0.0085*** (-3.75)
R_vol	0.0040*** (5.29)	0.0098*** (6.05)	-0.0133 (-1.10)	0.0005 (1.33)	0.0045** (2.19)	0.0472*** (4.06)	0.0226 (1.32)	0.0374** (2.49)	0.0127** (2.46)	-0.0007 (-0.18)
Joneses	-0.0343 (-1.12)	-0.0019 (-0.14)	-0.0155 (-0.81)	0.0556*** (3.76)	0.0104 (0.60)	0.0274 (0.63)	-0.0104 (-0.84)	0.1292** (2.16)	0.4535** (2.37)	-0.0063 (-0.37)
I>97*Joneses	0.0212*** (3.07)	0.0130*** (3.39)	0.0278*** (3.73)	0.0038 (0.74)	0.0387*** (5.46)	0.0244 (1.71)	0.0222*** (3.39)	0.0128 (0.55)	-0.1242* (-2.2)	0.0290*** (5.23)
constant	-0.3878** (-2.21)	0.0808 (0.31)	-0.2013 (-1.08)	0.0494 (0.12)	-0.4172 (-1.41)	0.6339 (0.59)	0.8179 (1.71)	1.0279 (0.90)	7.3576*** (3.95)	-1.1135*** (-6.91)
Adj. R-squares	0.9413	0.9482	0.9249	0.9171	0.9727	0.8299	0.9355	0.8978	0.8886	0.9848
Observations	23	23	24	24	24	23	24	24	15	24

Note: The table reports the results of estimating model (22) economy by economy. “lngdppc” is the log *per capita* GDP, “mp” is the import propensity, “F\_open” is financial openness, “E\_vol” is exchange volatility, and “R\_vol” is international reserve volatility. “Joneses” is the Joneses variable defined by equation (23) in the text. “I>97\*Joneses” is the interactive Joneses variable  $I(t-1>97) * J_{i,t-1}$ . t-statistics are in parentheses. “\*\*\*”, “\*\*”, and “\*” denote significance at the 1%, 5% and 10% level, respectively.

For instance, the *per capita* output, propensity to import, and international reserve volatility variables are usually positive though not all of them are significant. Compared with the panel regression results, the *per capita* output is less likely to be significant – five out of ten estimates are significantly positive. Taiwan, on the other hand, displays a significantly negative output effect on international reserve accumulation. The propensity to import variable is significantly positive in seven of the ten cases. China, interestingly, has a negative propensity to import effect on international reserve hoarding. The effect of financial openness is weaker than that of trade openness. It is also weaker than the financial openness effect reported in Table 1. The individual exchange rate volatility effects also appear different from those under the panel specification.

One general observation is that the explanatory power recorded in Table 3.a is higher than the one under the panel specification. The adjusted R-squares estimates in Table 3.a are 80% or higher. The accommodation of economy-specific behavior gives a better fit to the data, even though the small sample size (relative to the number of regressors) may have “inflated” the goodness of fit measure.

The effects of the Joneses and the interactive Joneses variables are presented in Tables 3.b and 3.c. Apparently, the *per capita* output is affected the most by the presence of the added variables. In Table 3.b, seven of the ten Joneses coefficient estimates are positive and four of them are statistically significant. The Joneses effect seems quite prevalent in the aftermath of the 1997 crisis – the interactive Joneses variable has a positive coefficient estimate in nine of the ten cases reported in Table 3.c and six of these nine positive estimates are significant. It is also noted that the coefficient estimate of the Taiwanese interactive Joneses variable is significantly negative.

In the presence of the interactive variable, the Joneses variable is significantly positive for three economies; namely Japan, Singapore, and Taiwan. In the case of Taiwan, the negative interactive Joneses effect is weaker than the Joneses effect. There is still the Joneses effect in the post crisis period. However, unlike other economies, the Joneses effect experienced by Taiwan in the post-crisis period is weaker, instead of stronger. With Taiwan as the only exception, the results indicate that the Joneses effect is more prominent after 1997.

Table 4.a: Results from individual economies with the an alternative definition of the Joneses effect

	China	India	Indonesia	Japan	Korea	Malaysia	Philippines	Singapore	Taiwan	Thailand
lngdppc	0.1206*** (3.6)	0.0458 (0.86)	0.0099 (0.30)	0.0954*** (3.20)	0.1414*** (5.85)	0.0952 (0.68)	-0.0795 (-0.92)	0.1547 (1.53)	-0.4842*** (-3.46)	0.1363*** (3.23)
mp	-0.4710 (-1.51)	0.6770 (1.19)	0.5163* (1.90)	1.1368*** (6.55)	0.9141*** (4.38)	0.0851 (0.49)	0.4507*** (4.61)	-0.2172** (-2.15)	1.1941 (1.59)	0.3219** (2.64)
F_open	-0.2622 (-0.63)	-0.1935 (-0.36)	-0.9746* (-1.95)	-0.0042 (-0.05)	-0.5639** (-2.66)	-0.0205 (-0.09)	0.1351*** (3.32)	-0.0540 (-0.92)	0.1026 (0.21)	0.3339** (2.26)
E_vol	-0.0317 (-0.42)	-0.0054 (-1.46)	0.0001** (2.78)	0.0001 (0.19)	-0.0004*** (-4.37)	-0.2356** (-2.37)	-0.0085* (-2.00)	-0.3432 (-0.54)	-0.0235 (-0.74)	-0.0026 (-0.66)
R_vol	0.0046*** (5.28)	0.0113*** (4.87)	-0.0048 (-0.27)	0.0010*** (3.47)	0.0125*** (4.80)	0.0406*** (3.35)	-0.0097 (-0.49)	0.0301* (1.92)	0.0126 (1.81)	-0.0135* (-2.00)
Joneses_4	-0.0278 (-0.54)	-0.0122 (-0.44)	0.0379 (1.41)	0.0886*** (5.24)	-0.0388 (-1.15)	0.0536 (0.89)	0.0014 (0.06)	0.1686*** (3.09)	0.3376 (0.95)	0.0400 (1.28)
constant	-0.5737*** (-3.38)	-0.2777 (-1.11)	-0.0654 (-0.36)	-1.0950*** (-3.47)	-1.3863*** (-5.81)	-0.6238 (-0.63)	0.4765 (0.82)	-0.5079 (-0.49)	4.3506*** (3.37)	-0.9898*** (-3.76)
Adj. R-squares	0.9115	0.9146	0.8337	0.9198	0.9317	0.7883	0.8941	0.8791	0.8415	0.9439
Observations	23	23	24	24	24	23	24	24	15	24

Note: The table reports the results of estimating model (22) economy by economy. “lngdppc” is log *per capita* GDP, “mp” is propensity to import, “F\_open” is financial openness, “E\_vol” is exchange volatility, and “R\_vol” is international reserve volatility. “Joneses\_4” is the Joneses variable defined by equation (24) in the text. t-statistics are in parentheses. “\*\*\*”, “\*\*”, and “\*” denote significance at the 1%, 5% and 10% level, respectively.

Table 4.b: Results for individual economies with an alternative definition of period-specified Joneses effects

	China	India	Indonesia	Japan	Korea	Malaysia	Philippines	Singapore	Taiwan	Thailand
lngdppc	0.0784** (2.54)	0.0272 (0.69)	0.0207 (0.79)	0.0462 (1.70)	0.0521** (2.56)	-0.0346 (-0.23)	-0.1780** (-2.74)	0.1180 (1.20)	-0.4856** (-3.21)	0.1656*** (6.66)
mp	-0.3807 (-1.48)	0.1423 (0.33)	0.3919* (1.79)	0.6730*** (3.54)	0.0991 (0.55)	0.1851 (1.08)	0.3281*** (4.39)	-0.2167** (-2.26)	1.1875 (1.47)	0.0447 (0.53)
F_open	-0.0385 (-0.11)	0.3174 (1.23)	-0.3400 (-0.78)	-0.0407 (-0.61)	-0.1015 (-0.70)	-0.1010 (-0.47)	0.0879** (2.85)	-0.0566 (-1.02)	0.1075 (0.20)	0.3684*** (4.30)
E_vol	-0.0164 (-0.27)	-0.0028 (-1.01)	0.0000*** (2.49)	-0.0001 (-0.20)	-0.0001 (-1.60)	-0.1765* (-1.80)	-0.0060* (-1.95)	-0.3209 (-0.53)	-0.0220 (-0.51)	-0.0080*** (-3.28)
R_vol	0.0037*** (4.71)	0.0098*** (5.62)	-0.0148 (-1.03)	0.0006** (2.31)	-0.0007 (-0.26)	0.0462*** (3.95)	0.0192 (1.23)	0.0336** (2.24)	0.0125 (1.69)	-0.0042 (-1.00)
Joneses_4	-0.0323 (-0.77)	-0.0328 (-1.57)	-0.0166 (-0.62)	0.0606*** (3.92)	-0.0075 (-0.37)	0.0180 (0.30)	-0.0447** (-2.23)	0.1089* (1.74)	0.3678 (0.59)	-0.0089 (-0.45)
I>97*Joneses_4	0.0816*** (2.97)	0.0480*** (3.87)	0.0624*** (3.35)	0.0461*** (3.47)	0.1978*** (5.98)	0.0717* (1.85)	0.0760*** (4.26)	0.0660 (1.70)	-0.0214 (-0.06)	0.0771*** (5.92)
constant	-0.3433** (-2.16)	-0.1332 (-0.72)	-0.1090 (-0.75)	-0.5321* (-1.81)	-0.4210* (-1.99)	0.3471 (0.33)	1.1900** (2.70)	-0.1402 (-0.14)	4.3600** (3.14)	-1.0978*** (-7.17)
Adj R-squares	0.9406	0.9545	0.8961	0.9514	0.9776	0.8161	0.9474	0.8912	0.8189	0.9813
Observations	23	23	24	24	24	23	24	24	15	24

Note: The table reports the results of estimating model (22) economy by economy. “lngdppc” is *log per capita* GDP, “mp” is propensity to import, “F\_open” is financial openness, “E\_vol” is exchange volatility, and “R\_vol” is international reserve volatility. “Joneses\_4” is the Joneses variable defined by equation (24) in the text. “I>97\*Joneses\_4” is the interactive Joneses variable  $I(t-1>97) * J_{i,t-1}$ . t-statistics are in parentheses. “\*\*\*”, “\*\*”, and “\*” denote significance at the 1%, 5% and 10% level, respectively.

The economy-by-economy results pertaining to the alternative definition of the Joneses variable are given in Tables 4.a and 4.b. A comparison of the coefficient estimates of the Joneses and the interactive Joneses variables leads to a similar observation – the Joneses effect is more prevalent and prominent in the post-1997 crisis sample. Specifically, eight of the ten interactive terms are significantly positive and only two Joneses variables are significant.

Although there are discernable differences in Tables 3.b, 3.c, 4.a, and 4.b, the performance of the two alternative specifications of the Joneses variables is quite comparable. The differences include the Joneses variable based on the four-economies specification is only significant in two cases in Table 4.a while it is significant in four cases in Table 3.b. On the other hand, the Joneses effect is stronger in the post crisis period with the four-economies Joneses specification. Similar to the panel data results, the regressions with the four-economies Joneses variable have adjusted R-squares estimates slightly less than those with the Joneses variable defined by all the economies in the sample. Nonetheless, these two sets of results are suggestive of the presence of the keeping up with the Joneses effect.

These regressions results, especially those allowing for economy-specific behavior, the selected variables (both the traditional macroeconomic variables and the two Joneses variables) explain the evolution of the holdings of international reserves quite well. To offer some insights on the debate of excessive international reserve hoarding, we examine the estimated residual that is given by the difference between the actual level of international reserve holdings and the level explained by the regressors. Thus, a positive estimated residual suggests that the actual holding level is higher than the one warranted by the model.

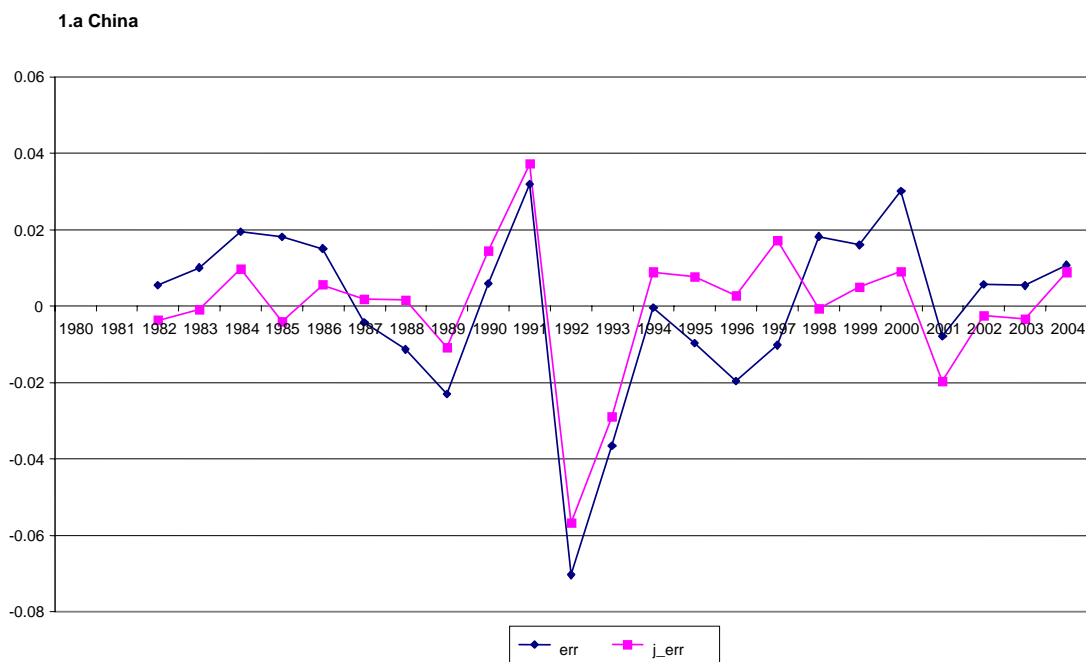
According to the argument, the Joneses effect will lead to a level of international reserves that is higher than the one implied by fundamentals alone. If the Joneses effect is in operation but it is not accounted for in the regression analysis, the observed international reserves will appear higher than they should be. Thus, with the Joneses effect, the predicted value of international reserve holding should be higher in the presence of Joneses variables than without them.

Figure 1 presents graphs of estimated residuals from the model with only traditional macroeconomic variables as regressors and from the model that also includes both the Joneses and the interactive Joneses variables. Since the inclusion of the Joneses variables tend to improve the goodness of the fit, it is not surprising to observe that estimated residuals from the model allowing for the Joneses effect are in general smaller than those from the model without the

Joneses variable. Another way to interpret the result is that the incorporation of the Joneses effect makes the observed international reserve holdings closer to the predicted values. During the 2000 to 2004 period, the presence of the Joneses variables will in general reduce the estimated level of “excessive” holding. Indeed, the Joneses effect reverses the inference from “excessive” holding to “deficient” holding in the case of India, Philippines, and Thailand.

In sum the results from both the panel and economy-by-economy regressions are, in general, supportive of the notion that an economy’s international reserve demand behavior is affected by other economies’ action.<sup>16</sup>

Figure 1: Estimated Residuals from Models With and Without the Joneses Effect



<sup>16</sup> As a robust check, we added the lagged dependent variable as one of the regressors. The results, provided in the Appendix, on the Joneses results are qualitatively the same as those reported in the text.



























































