REVISITING MRS. MACHLUP'S WARDROBE: THE ACCUMULATION OF INTERNATIONAL RESERVES, 1992-2001

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1. Introduction

Having gone out of fashion in the early 1970s with the introduction of flexible exchange rates and the growth of international capital markets, since the 1990s more interest has once again been shown in international reserves. This is, in part, because it is observed that many countries have accumulated large levels of reserves. Indeed, reserve accumulation has been globally widespread. In an attempt to explain this phenomenon, various studies have empirically investigated reserve behaviour; e.g. Aizenman and Marion (2004), IMF World Economic Outlook (2003). In the main, these have built on a reasonably well established theory of the demand for international reserves; e.g. Clark (1970), Frankel and Jovanovic (1981).

The studies suggest that up until the latter part of the 1990s the accumulation of reserves was largely consistent with conventional models. Beyond this time, however, the models generally under-predicted the demand for reserves. The challenge has been to explain this under-prediction.

Various suggestions have been put forward. One is the rise of a new mercantilism. A second is the response to the East Asian crisis in 1997/98, with countries seeking to self-insure against future crises. A third is the response to IMF involvement and conditionality, with countries seeking to effectively substitute out of future IMF arrangements. A fourth is that countries want to retain access to capital markets, and creditworthiness is positively associated with reserve levels. In particular, these explanations have been offered in the context of Asia, where the excess reserve accumulation was identified as being pronounced.

In what follows we investigate these issues empirically. How widely has the tendency to accumulate reserves been seen? Does the incidence of a currency crisis increase the subsequent demand for reserves? Do countries make choices between different combinations of exchange rate regime and reserve holding? Does an arrangement with the IMF encourage countries subsequently to build up reserves more than they otherwise would have done? Do different patterns emerge depending upon the measure of reserves used?

In addition to these questions, we revisit and test a much older theory of the demand for international reserves. Machlup (1966) argued that the behaviour of monetary authorities with regards reserve accumulation was very much like that of his wife with regards her wardrobe. Irrespective of how many clothes she possessed, Machlup observed her tendency to add to her stock of them year upon year. This became known as the Mrs. Machlup's Wardrobe Theory

of International Reserves. We test whether monetary authorities during the 1990s exhibited a Mrs. Machlup syndrome.

2. Empirical Analysis

The data come from the World Development indicators (WDI), the Ivanova et al. (2003) database and Reinhart and Rogoff (2004). They include all countries reported in WDI for which reserves data (excluding gold) are available. The frequency is annual and covers the period 1992-2001. Throughout the econometric analysis we use five measures of reserve adequacy:[2] reserves in current US dollars divided by the US deflator (RESUSDEF); reserves to GDP (RESGDP); reserves to M2 (RESM2); reserves to external debt (RESDEBT); and reserves in months of imports (RESMIMP). We also examine a sub-sample of countries classified as 'emerging' by FTSE.[3]

During our sample period the demand for reserves increased substantially, a picture confirmed in Figure 1. For example, average reserves rose from 10.9 percent of GDP in 1992 to 15.9 by 2001. A similar pattern can be identified in other measures. In this section, we model demand behaviour using static and dynamic panel data estimations.

First, we estimate a specification of the form[4]

$$y_{it} = \alpha + x'_{it}\,\beta + \varphi_i + \vartheta_t + \omega_{it},$$

where x'_{it} is a vector of explanatory variables including logged population, logged real GDP per capita, logged domestic interest rate, logged ratio of imports to GDP, the current account balance (percent of GDP), the 'coarse' classification of the exchange rate regime of Reinhart and Rogoff (2004), a crisis dummy and an IMF dummy. The first of these dummies takes a value 1 for all country observations following a 'crisis event', where a (country-specific) crisis observation is produced whenever an exchange rate value exceeds the average plus 1.5

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[2] See Aizenman and Marion, 2001.

[3] Argentina, Brazil, Chile, China, Colombia, Czech Republic, Egypt, Hungary, India, Indonesia, Israel, Malaysia, Mexico, Morocco, Pakistan, Peru, Philippines, Poland, Russia, South Africa, South Korea, Taiwan, Thailand and Turkey.

[4] Levin et al. (2002) and Im et al. (2003) panel unit root tests of the logged series provide evidence that the series are stationary. These tables and descriptive statistics are available from the authors.

times the standard deviation of the country's exchange rate series.[5] The second dummy takes a value 1 for all country observations following the beginning of an IMF program recorded in the Ivanova et al. (2003) database.

The results in tables 1 and 2 indicate that: first, the current account balance is positively associated with demand for reserves. This result, however, does not hold for emerging economies. Second, less flexible exchange rate regimes are associated with higher reserve holdings across the board. Third, the IMF experience seems to have a significant effect on accumulation of reserves in the world sample. In the emerging economies' sample, however, the IMF effect is only apparent when examining reserves in relation to debt. For this sub-group, crises (irrespective of the IMF's involvement) exert a significant effect on subsequent reserve behaviour.[6] Fourth, even though the domestic interest rate is not significant in the world sample, it is significant and positive in the emerging sample. In these economies, financial liberalization led to an increase in interest rates, which attracted capital inflows. The authorities did not want the exchange rate to appreciate so intervened in the FX market and accumulated reserves. A fifth result is that despite the high explanatory power of the specifications, the time effects have been shifting upwards.[7]

Next, we examine the 'persistence' of international reserve hoarding. Our model is

$$y_{it} = \rho y_{it-1} + x'_{it} \beta + \varphi_i + \omega_{it},$$

and includes the lagged dependent variable in the RHS. Tables 3 and 4 show GMM estimation results for the two samples. Controlling for persistence affects the significance of some of the variables. More specifically, the IMF variable does not have any explanatory power (with the exception of one regression). The effect of crises remains but only in the world sample. There is still evidence for the importance of the current account and the exchange rate regime. The persistence term is significantly positive in all individual regressions. The domestic interest rate continues to have a significant positive effect.

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[5] This definition of a crisis has been used in several studies in the literature. For a review see Chui and Gai (2005).

[6] The two dummies have a low degree of correlation of about 21 percent.

[7] The reserves-to-external-debt ratio is the exception to this trend.

3. Conclusions

Reserve behaviour during the 1990s can only in part be explained by determinants found in conventional models. Our results imply that reserve accumulation may also have been positively associated with the incidence of crises. A crisis encourages countries to build up reserves more than they would otherwise have done, perhaps not only as a way of minimizing the risk of future crises, but also as a way of dealing with crises should they occur.

Additionally, having had a program with the IMF, countries are generally encouraged to accumulate reserves to a greater extent than conventional determinants would suggest, implying that they attach a higher cost than they anticipated to IMF conditionality. These relationships, however, show a tendency to vary with the sample and with the measure of reserves used.

We also find significant support for the Mrs. Machlup's Wardrobe Theory. Time exerts a significant positive impact on reserve accumulation. We do not seek to explain this formally, but perhaps monetary authorities perceived the period covered by our study as one of increasing financial turbulence and potential vulnerability, irrespective of whether crises actually occurred. They may also have experienced a change in their preferences over time towards income stability as opposed to income level. The question remains unanswered as to whether the time effect will endure. It may be that we are picking up a process of gradual 'stock' adjustment which will cease once reserves, as perceived by monetary authorities, reach an optimal level.

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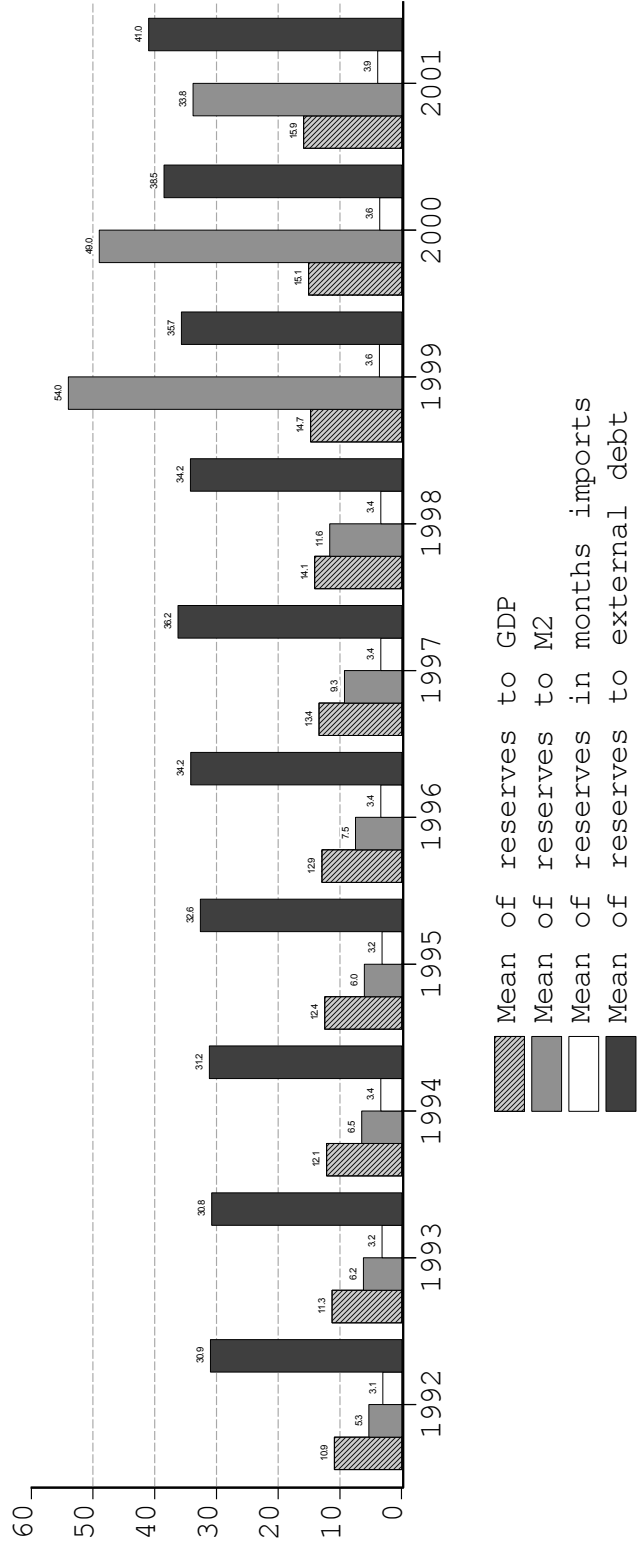
Figure 1: Average reserves 1992-2001, All economies

Mean of reserves to GDP
Mean of reserves to M2
Mean of reserves in months imports
Mean of reserves to external debt

Table 1: Static panel with country and time effects –

All economies

	LRESUSDEF	LRESGDP	LRESDEBT	LRESM2	LRESMIMP
LOG(POP)	1.35***	0.38	3.64***	-0.14	0.74**
	(0.32)	(0.30)	(0.77)	(0.72)	(0.32)
LOG(DIR)	-0.01	-0.01	0.02	-0.05	0.02
	(0.03)	(0.03)	(0.05)	(0.04)	(0.03)
LOG(IM_GDP)	-0.25***	0.14*	0.01	0.07	-0.63***
	(0.09)	(0.07)	(0.15)	(0.15)	(0.12)
LOG(RGDP_PC)	0.86***	-0.37**	0.74***	-1.04***	-0.41***
	(0.18)	(0.16)	(0.24)	(0.36)	(0.15)
CRISIS_EFFECT	0.14	0.30	0.08	0.60***	0.23
	(0.20)	(0.19)	(0.24)	(0.14)	(0.13)
IMF_EFFECT	0.30***	0.31***	0.36***	0.13**	0.23
	(0.09)	(0.10)	(0.11)	(0.07)	(0.06)
CA_GDP	0.01***	0.02***	0.02***	0.01***	0.02
	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)
EXRR2	-0.07***	-0.05***	-0.06***	-0.07***	-0.04***
	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)
C	-5.91	-1.63	-60.06***	8.44	-5.30
	(5.54)	(5.03)	(13.90)	(14.16)	(6.19)
Obs.	1045	1045	748	921	1039
Panels	121	121	88	108	120
Period	1992-01	1992-01	1992-01	1992-01	1992-01
R-sq.	0.96	0.8	0.84	0.9	0.81

Notes: Estimation with least squares dummy variables and cross-country, time-varying fixed

effects. Standard errors and covariance are White cross-section.

Table 2: Static panel with country and time effects –

Emerging economies

	LRESUSDEF	LRESGDP	LRESDEBT	LRESM2	LRESMIMP
LOG(POP)	-0.01	-0.75	-1.34	-1.95	-1.04
	(0.78)	(0.76)	(1.22)*	(1.23)	(0.90)
LOG(DIR)	0.11**	0.12*	0.11*	-0.03	0.12**
	(0.05)	(0.05)	(0.06)	(0.05)	(0.05)
LOG(IM_GDP)	0.13	0.53*	0.12	0.33*	-0.43***
	(0.12)	(0.15)	(0.21)	(0.18)	(0.14)
LOG(RGDP_PC)	1.41***	-0.01	1.45*	0.07	0.42
	(0.42)	(0.35)	(0.45)	(0.34)	(0.36)
CRISIS_EFFECT	0.35**	0.43*	0.18	0.36*	0.31***
	(0.15)	(0.14)	(0.12)	(0.12)	(0.11)
IMF_EFFECT	0.10	0.15	0.35**	0.16	0.18
	(0.16)	(0.15)	(0.15)	(0.13)	(0.15)
CA_GDP	-0.00	0.01	0.00	0.01	0.01**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
EXRR2	-0.16***	-0.15***	-0.19***	-0.09***	-0.12***
	(0.03)	(0.04)	(0.03)	(0.03)	(0.03)
C	11.93	13.70	15.32	31.40	17.66
	(16.38)	(16.17)	(23.69)	(-1.95)	(18.66)
Obs.	199	199	17	199	199
Panels	21	21	19	21	21
Period	1992-01	1992-01	1992-01	1992-01	1992-01
R-sq.	0.9	0.86	0.83	0.84	0.81

Notes: Estimation with least squares dummy variables and cross-country, time-varying fixed

effects. Standard errors and covariance are White cross-section.

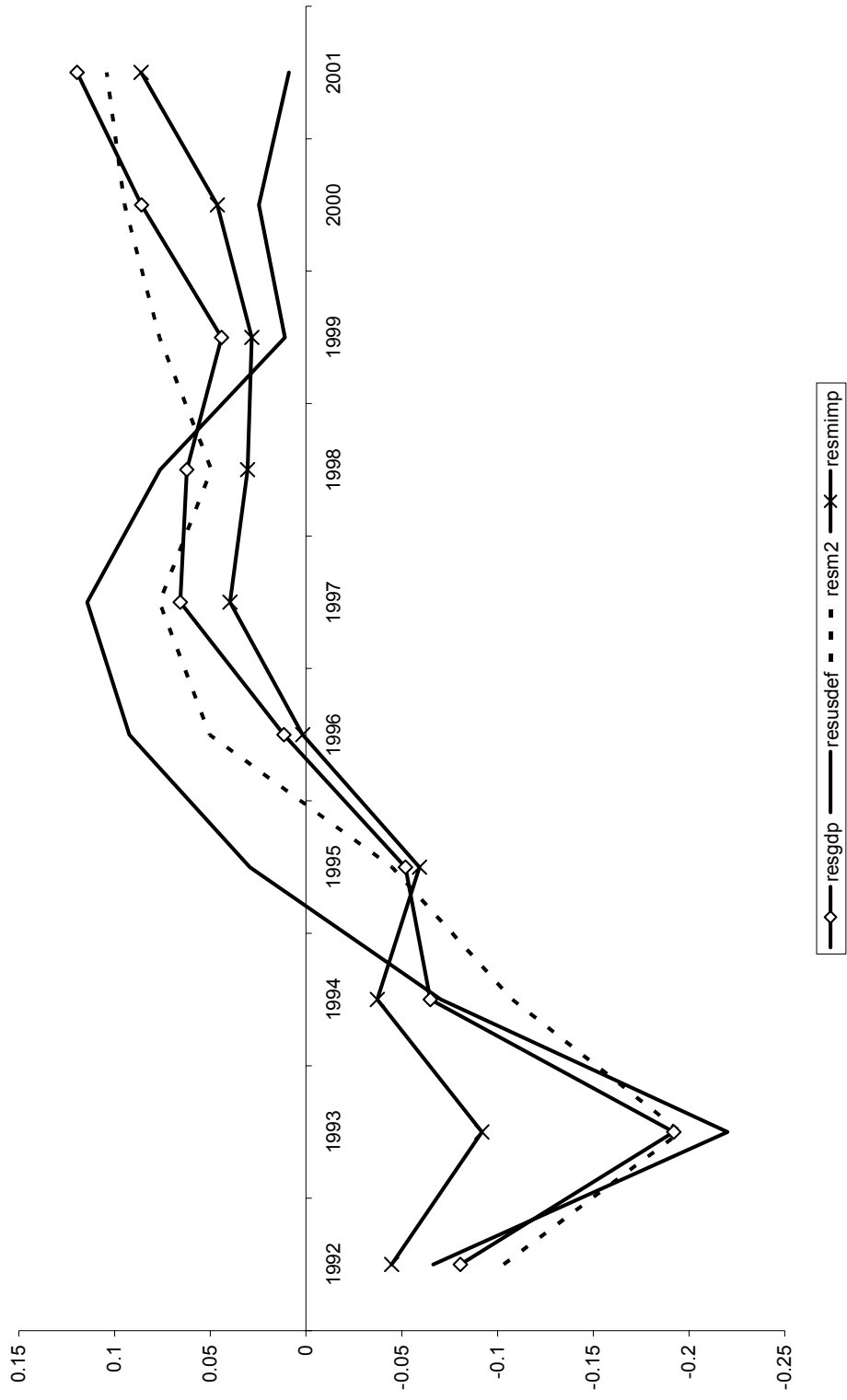Figure 2: Increasing time effects, all economies

Table 3: Dynamic Panel –

All economies

	LRESUSDEF	LRESGDP	LRESDEBT	LRESM2	LRESMIMP
Lag Dependent	0.32***	0.31***	0.59***	0.46***	0.21***
	(0.05)	(0.04)	(0.05)	(0.04)	(0.05)
LOG(POP)	0.97***	0.03	0.84**	-0.36	-0.24
	(0.35)	(0.36)	(0.37)	(0.29)	(0.36)
LOG(DIR)	0.12***	0.09***	0.19***	0.06	0.07**
	(0.04)	(0.03)	(0.04)	(0.04)	(0.04)
LOG(IM_GDP)	-0.18	0.18	-0.03	0.02	-0.74***
	(0.13)	(0.12)	(0.15)	(0.08)	(0.11)
LOG(RGDP_PC)	0.88***	-0.12	-0.34	0.21	0.03
	(0.21)	(0.23)	(0.26)	(0.20)	(0.23)
CRISIS_EFFECT	0.56***	1.25***	0.61***	0.78***	1.55***
	(0.14)	(0.24)	(0.20)	(0.17)	(0.24)
IMF_EFFECT	0.26**	0.07	-0.03	0.06	0.00
	(0.11)	(0.10)	(0.10)	(0.10)	(0.13)
CA_GDP	0.00	0.01**	0.00	0.01**	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
EXRR2	-0.09***	-0.05	-0.16***	0.02	-0.04
	(0.03)	(0.05)	(0.04)	(0.04)	(0.04)
Obs.	922	920	657	810	907
Panels	120	120	87	106	119
Period	1992-01	1992-01	1992-01	1992-01	1992-01

Notes: Panel generalised method of moments with cross section fixed effects (White period standard errors and covariance). Method of transformation: first differences.

Table 4: Dynamic Panel –

Emerging economies

	LRESUSDEF	LRESGDP	LRESDEBT	LRESM2	LRESMIMP
Lag Dependent	0.28***	0.32***	0.48**	0.14**	0.48***
	(0.10)	(0.10)	(0.26)	(0.07)	(0.12)
LOG(POP)	0.78	-0.52	-2.15	-1.30	-0.42
	(2.52)	(3.66)	(4.00)	(1.39)	(2.85)
LOG(DIR)	0.10**	0.05	0.12**	0.01	0.02
	(0.05)	(0.05)	(0.07)	(0.04)	(0.06)
LOG(IM_GDP)	0.22	0.55	0.75	0.61**	0.02
	(0.60)	(0.51)	(0.79)	(0.25)	(0.36)
LOG(RGDP_PC)	1.45	0.95	0.28	0.30	0.20
	(1.31)	(1.41)	(1.66)	(0.50)	(1.24)
CRISIS_EFFECT	0.69**	0.08	0.03	0.88	0.31***
	(0.27)	(0.35)	(0.15)	(0.32)	(0.23)
IMF_EFFECT	-0.02	-0.02	0.08	-0.02	0.05
	(0.12)	(0.20)	(0.22)	(0.11)	(0.15)
CA_GDP	-0.00	0.02	0.04**	0.01	0.03
	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
EXRR2	-0.20**	-0.10	-0.33***	-0.11	-0.04***
	(0.08)	(0.07)	(0.12)	(0.04)	(0.04)
Obs.	178	178	157	178	178
Panels	21	21	19	21	21
Period	1992-01	1992-01	1992-01	1992-01	1992-01

Notes: Panel generalised method of moments with cross section fixed effects (White period standard errors and covariance). Method of transformation: first differences.