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Finance, investment, and growth: Time series evidence from 10 Asian economies

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Abstract

This paper takes a time series approach to investigate whether the intensity of financial intermediation promoted investment and growth in 10 Asian economies over the 1950–2000 period. We do this by using vector autoregressive models (VARs) and vector error correction models (VECMs) to examine the nature of statistical causality between measures of financial and real sector activity. Our results indicate that finance did, on the whole, act as a driving force behind investment. Evidence of a role for financial factors in output is weaker. The findings are consistent with a factor accumulation channel as the primary mechanism through which the financial sector influenced macroeconomic outcomes in these countries.

JEL classification: E44; O16; O53
Keywords: Financial intermediation; Investment; Factor accumulation; Vector autoregression; Vector error correction model

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1. Introduction

The relationship between financial development and economic growth, particularly for the South and East Asian economies, has been a topic of renewed interest in the macroeconomics and development literatures over the past decade. At the same time, identifying the direction of causation remains elusive. This study takes a time series approach to the question and finds evidence to support the hypothesis that finance, on the whole, did indeed exert an independent influence on investment and growth in a sample of 10 Asian economies over the 1950–2000 period. The analysis takes a country-by-country approach so that the channels of finance-led growth can be elucidated more clearly than might be possible in a cross-country framework where implicit homogeneity restrictions are usually imposed (Demetriades and Hussein, 1996).

The traditional literature includes two distinct views of the finance–growth nexus. The first, pioneered by Schumpeter (1911), emphasizes a proactive role for financial services in promoting growth and development. Goldsmith (1969) and McKinnon (1973) provided some analytic foundations for this view and supported it with simple but persuasive observations. These treatments stress the role of repression as manifested in government interventions on the financial sector, such as ceilings on interest rates and directed credit programs, in hampering financial development and thereby reducing rates of factor accumulation and productivity growth. Recent contributions to the endogenous growth theory, typified in models by Greenwood and Jovanovic (1990) and Bencivenga and Smith (1991), have characterized the role of services provided by financial intermediaries even more explicitly. According to these models, financial intermediaries gather and analyze information and facilitate better risk sharing among individuals, thus allowing credit to be allocated more efficiently.

The alternative view suggests that these channels, while potentially important, are probably overstressed, and that increases in the demand for financial services resulting from economic growth are the driving forces behind the development of the financial sector. This mechanism is stressed in the work of Robinson (1952), and summarized in her famous quote that "where enterprise leads, finance follows". Other studies even suggest a negative effect of financial development on growth (Van Wijnbergen, 1983; Buffie, 1984). This arises from the possibility that a financial system may reduce the credits available to domestic producers. In other words, financial intermediaries compete with domestic firms, which could lead to a credit crunch that lowers investment and productivity.

Among the studies that argue for the first view, two distinct channels of finance-led growth have emerged. The first stresses the role of intermediaries in allocating resources more efficiently. This so-called "total factor productivity" channel operates through innovative financial technologies that ameliorate informational asymmetries and lead to better project selection and monitoring (Townsend, 1979; King and Levine, 1993a). The second "factor accumulation" channel focuses on the spread of organized finance in place of self-finance and the resulting improvements in the ability of intermediaries to mobilize otherwise unproductive resources and help firms to overcome project indivisibilities (Gurley and Shaw, 1955; Bencivenga and Smith, 1991; Rousseau, 1999; Xu, 2000; Bell and Rousseau, 2001).

Studies of potential causality between finance and growth can also be classified by their econometric approaches. King and Levine (1993b) ran cross-country growth regressions that covered 80 countries and found that those with greater initial levels of financial activity grew faster over the 1960–1990 period than those with less financial development. They also found that financial development promoted productivity growth by inducing technological innovation. Levine and Zervos (1998), taking a similar cross-country approach, found that the development of banks and stock markets also has a positive effect on growth. However, the Barro (1991) specification upon which these regressions are based does not encompass a test for reverse causation that is justified by growth theory. Further, the cross sectional approach assumes that countries have stable growth paths and share similar economic structure, populations and technologies—assumptions that are at odds with observed economic patterns across countries. The use of data averaged over time may also obscure the evolution of key variables and their causal relationships. Thus, while much has been learned about the nature of the finance–growth nexus from cross-country studies, the robustness of these findings to different econometric methodologies requires further investigation (Arestis and Demetriades, 1997).

A popular alternative approach to examining the relationship between finance and growth is time series analysis. The results have been largely mixed. For example, Jung (1986) ran vector autoregressions (VARs) in levels on post-1960 annual time series for financial and real variables, and found bi-directional causality in most cases. Demetriades and Hussein (1996) studied 16 developing countries and found little evidence for an independent influence of financial development on growth, though they did find many bi-directional relationships. Rousseau and Wachtel (1998) applied the VAR approach to five industrialized countries over the 1870–1929 period and found strong uni-directional links from finance to growth. They also estimated a vector error correction model (VECM) for each country and found evidence of an economically important long-run relationship between the two sectors. Bell and Rousseau (2001) used this approach for post-independence India and found that financial intermediaries played a more emphatic role in promoting investment than in increasing total factor productivity, and interpreted this as evidence for the presence of a factor accumulation channel.

This study considers 10 Asian countries (India, Indonesia, Japan, Korea, Malaysia, Pakistan, Philippines, Singapore, Sri Lanka, and Thailand) from 1950 to 2000. In some countries the data are not available for the full 50 years and the time spans are reduced accordingly. Our multivariate analysis uses both VARs and VECMs, and finds a strong uni-directional link from finance to investment for most of these countries, which is consistent with a channel involving factor accumulation. There is less support for a causal link from finance to the level of output. This suggests that, like the case of India described by Bell and Rousseau (2001), and the sample of 41 countries considered by Xu (2000), resource mobilization may be the key mechanism at work. The result is also consistent with the seminal studies of Gerschenkron (1962) and Cameron et al. (1967), which posit a particularly important role for finance in the early stages of economic development.

2. Methodology

In this section, we describe the measures of financial and real activity that we consider in our analysis, and outline the econometric methodology.

The first measure of financial development is the difference between broadly defined and narrow money ($M2 - M1$). As in Xu (2000), we subtract narrow money from broad money because the currency component of $M2$ is not generally intermediated through the banking system. Credit allocated to the private sector (CPV) serves as an alternative measure. We believe that credit allocated to the private sector normally yields a higher return than credits allocated to the public sector and is more likely to reflect fluctuations in the level of intermediated finance. Turning to the real side, we use gross domestic product (GDP) and gross domestic fixed investment (I) as measures of economic performance. All variables are expressed in real per capita terms and were obtained from the 2001 version of the International Monetary Fund's International Financial Statistics (IFS). [1]

To examine interactions among these variables through time, our baseline specifications include either investment or output as the real sector measure and either $M2 - M1$ or CPV as the measure of financial development. In addition, we always include narrow money ($M1$) because, in developing economies in particular, currency serves as an important store of value and thus complements intermediated finance in facilitating the accumulation of capital (see McKinnon, 1973).

We choose to focus on the effects of the intensity of financial intermediation on output and investment separately to avoid problems of collinearity between output and investment and to conduct our examination in a parsimonious framework. It is of course reasonable, as in Xu (2000), to model output and investment jointly, as theory would suggest, but with limited sample sizes such as ours this might prove less useful in identifying the dominant channel through which finance affects real activity in the short and medium term. Further, if finance affects the quality of investment as well as its quantity, a stronger effect of finance on investment than on output in a VAR system might be consistent with increases in total factor productivity that do not manifest in the output equation.

The exact forms of our tri-variate models and the appropriate tests for short- and long-run statistical causation will depend critically on the stationarity and cointegration properties of each system in our 10-country sample. We start by using both the Augmented Dickey Fuller (ADF) and Phillips and Perron (PP) tests to investigate the stationarity properties of each measure of financial and real activity, and

[1] We use IFS line 55l as a measure of broad money. However, when line 55l is not available, we use line 34 plus line 35, which is $M2$. Thus $M2 - M1$ is either line 55l minus line 34 or line 35. For the credits allocated to the private sector, we use IFS line 22d.

include a constant and time trend in the tests to reflect the trending nature of these series. [2]

After testing for stationarity, we apply the Johansen (1991) test to determine whether the variables in each system are cointegrated, and if so, how many cointegrating vectors can be identified.

Our baseline VAR in levels takes the form [3]

$$x_{1,t} = a_{1,0} + \sum_{i=1}^{k} a_{1,i}x_{1,t-i} + \sum_{i=1}^{k} b_{1,i}x_{2,t-i} + \sum_{i=1}^{k} c_{1,i}x_{3,t-i} + u_{1,t}, \tag{1a}$$

$$x_{2,t} = a_{2,0} + \sum_{i=1}^{k} a_{2,i}x_{1,t-i} + \sum_{i=1}^{k} b_{2,i}x_{2,t-i} + \sum_{i=1}^{k} c_{2,i}x_{3,t-i} + u_{2,t}, \tag{1b}$$

$$x_{3,t} = a_{3,0} + \sum_{i=1}^{k} a_{3,i}x_{1,t-i} + \sum_{i=1}^{k} b_{3,i}x_{2,t-i} + \sum_{i=1}^{k} c_{3,i}x_{3,t-i} + u_{3,t}, \tag{1c}$$

where x_1 is a measure of economic performance (GDP or investment), x_2 is narrow money, x_3 is a measure of financial development ($M2 - M1$ or CPV), and k is the lag order as selected by nested likelihood ratio tests. [4]

A finding of cointegration with the Johansen test indicates that there is a stable long-run relationship among the variables in the system. The sign on each coefficient in the cointegrating vector represents the direction in which each variable moves in response to perturbations in the stationary linear combination (i.e., the error correction term) that stabilizes the model.

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[2] The ADF test (Said and Dickey, 1984) applies OLS to the equation

$$\Delta y_t = \alpha_0 + (\alpha_1 - 1)y_{t-1} + \alpha_2 t + \sum_{k=1}^{K} \delta_k \Delta y_{t-k} + e_t$$

where k is the number of lags as determined by the Akaike Information Criterion (AIC) and/or the Schwartz Bayesian Criterion (SBC). The null hypothesis is that the series has a unit root (i.e., $\alpha 1 - 1 = 0$). The Phillips and Perron (PP, 1989) test provides an alternative statistic that makes a non-parametric correction for the $\alpha 1 - 1$ coefficient in the ADF specification in place of the Δy_{t-k} terms, with inferences based on the same tables used for the ADF. While the Dickey–Fuller test is based on the error terms being white noise, the PP test allows the disturbances to be weakly dependent and heterogeneous. Therefore, the PP test is more robust to serial correlation and various forms of time-dependent heteroscedasticity.

[3] The Baseline VAR can be expressed more compactly as $\Phi(L)x_t = a_0 + \mu_t$, where $\Phi(L)$ is a polynomial in the lag operator (L) of order k. We prefer the more explicit notation in Eqs. (1a), (1b), and (1c) because it simplifies the exposition of our findings.

[4] For example, if we want to test the null hypothesis of $k = i$ against the alternative hypothesis of $k = j$, the likelihood ratio is computed by $(T - c)(\log \mid \Sigma_i \mid - \log \mid \Sigma_j \mid)$, where T is the number of observations, c is the number of parameters in the unrestricted system and $\log \mid \Sigma_k \mid$, $k = i$ or j is the natural logarithm of the determinant of Σ_k. The likelihood ratio test is distributed as χ^2 with degrees of freedom equal to the number of coefficient restrictions in the system.

In the cointegrated case, the VECM representation is appropriate for examining long-run relationships between finance and economic performance, and takes the form

$$\Delta x_{1,t} = \mu_1 + \sum_{i=1}^{k-1} \lambda_{1,i}\Delta x_{1,t-i} + \sum_{i=1}^{k-1} \delta_{1,i}\Delta x_{2,t-i} + \sum_{i=1}^{k-1} \eta_{1,i}\Delta x_{3,t-i} + \alpha_1(\beta_1 x_{1,t-1} + \beta_2 x_{2,t-1} + \beta_3 x_{3,t-1}), \tag{2a}$$

$$\Delta x_{2,t} = \mu_2 + \sum_{i=1}^{k-1} \lambda_{2,i}\Delta x_{1,t-i} + \sum_{i=1}^{k-1} \delta_{2,i}\Delta x_{2,t-i} + \sum_{i=1}^{k-1} \eta_{2,i}\Delta x_{3,t-i} + \alpha_2(\beta_1 x_{1,t-1} + \beta_2 x_{2,t-1} + \beta_3 x_{3,t-1}), \tag{2b}$$

$$\Delta x_{3,t} = \mu_3 + \sum_{i=1}^{k-1} \lambda_{3,i}\Delta x_{1,t-i} + \sum_{i=1}^{k-1} \delta_{3,i}\Delta x_{2,t-i} + \sum_{i=1}^{k-1} \eta_{3,i}\Delta x_{3,t-i} + \alpha_3(\beta_1 x_{1,t-1} + \beta_2 x_{2,t-1} + \beta_3 x_{3,t-1}), \tag{2c}$$

where x_1, x_2, and x_3 are defined as before and the β_i are elements of the cointegrating vector. [5] These elements are combined with the data to construct the stationary linear combination that enters the model with a single lag as the final term. The sign and size of the coefficient on this error correction term (ECT), given by the α_i in each equation, represent the direction and speed of adjustment of the dependent variable to temporary deviations from the long-run relationship.

The statistical significance of the coefficient on the ECT in each equation can be used to investigate the weak exogeneity of the financial variables. For example, a negative and significant α on the ECT in Eq. (2a), when combined with a negative loading on finance in the normalized cointegrating vector, [6] indicates that the performance measure (I or GDP) rises in response to downward deviations from the system's stationary long-run path, including deviations caused by increases in the financial variable. On the other hand, an insignificant coefficient on the ECT in the "finance" Eq. (2c) suggests that the financial variable does not adjust in the long run to any perturbations in the system, regardless of their source.

The VECM representation is useful when the focus is on long-run relationships in a VAR system, yet it is likely that shorter-term movements in the financial variables affect investment and output as well. Combining such short-run effects with the long run in a single test might therefore allow us to draw more general conclusions. This

[5] The VECM is more commonly written in vector notation as

$$\Delta x_t = A_0 + \sum_{i=1}^{k-1} \Gamma_i \Delta x_{t-i} + \pi x_{t-1} + e_t$$

where Γ is a $(k-1)\times(k-1)$ matrix of coefficients and $\pi = \alpha\beta'$.

[6] A cointegrating vector is "normalized" by transforming the loadings to set the first element to unity.

can be done by running the VARs in levels and computing tests for Granger non-causality on each variable block.

Toda and Phillips (1993), however, have shown that in general the asymptotic distributions of the Wald test for Granger non-causality in levels VARs with integrated regressors are nonstandard. Sims et al. (1990), while recognizing this, show analytically that the Wald test for a tri-variate system with a single cointegrating relationship is asymptotically distributed as chi-square and therefore valid as a test for Granger non-causality. [7] In some cases, however, we will find multiple cointegrating vectors or be uncertain about the presence of a cointegrating relationship.

Toda and Yamamoto (1995) have proposed an empirical technique for retaining the levels VAR in these less standard cases using a modified Wald test (MWALD). Specifically, the MWALD statistic has an asymptotic chi-square distribution in a VAR of order (k + dmax), where dmax is the highest order of integration that we suspect might occur in the system. In practice, this involves estimating a (k + dmax)-order VAR, with k determined by nested likelihood ratio tests, and applying the MWALD test for the zero restriction on only the lag coefficients that are given by k. This test can also be applied when Johansen tests are unable to reject the null hypothesis of no cointegration.

To summarize, we estimate a VECM in all cases of cointegration. We also apply the Sims et al. (1990) result to test for Granger non-causality in levels when our tri-variate VAR systems have a single cointegrating vector. We use the Toda and Yamamoto (1995) test when no cointegration or more than one cointegrating vector is found. We prefer the strategy of using the lag lengths suggested by our nested likelihood ratio tests and Johansen tests whenever possible because the additional lag term needed to implement the Toda and Yamamoto test results in less efficient inference in a VAR system that is actually cointegrated. This loss of efficiency can be considerable.

After considering Granger-causal relationships between our financial and real sector variables, we compute the percentages of movements in the output and investment sequences that can be attributed to the financial variables at horizons of 3, 6, and 10 years using the variance decomposition. To implement this, we apply the Choleski decomposition to the variance–covariance matrix of the residuals from our VAR systems, which is sensitive to the ordering of the variables in the matrix. We use the results of our Granger-causality tests in the unrestricted VARs as a guide for choosing this ordering.

3. Results

In this section we present the results from tests for unit roots, cointegration, Granger non-causality, and weak exogeneity in our tri-variate systems.

[7] Toda and Phillips (1993, pp. 1–2), also acknowledge the validity of the Sims et al. (1990) result for cointegrated tri-variate VARs.

Table 1, which presents test statistics for both the ADF and PP tests, shows that the null hypothesis of a unit root cannot be rejected in the levels specification for any of the financial and economic time series that we consider under at least one of the tests. [8] However, the null hypothesis of a unit root is rejected for the first difference specification in all cases.

Given that we cannot reject that all variables are $I(1)$, we next perform cointegration tests to determine whether there are stable long-run relationships between our measures of economic performance and the financial variables. Table 2 shows stable long-run relationships between investment, narrow money and the difference between broad and narrow money for all 10 countries. Further, in nearly all cases we find a single cointegrating vector. This is apparent because both the maximum eigenvalue and trace tests (left hand column of each panel) reject the null hypothesis of no cointegration ($r = 0$) yet usually fail to reject that there is at most one cointegrating vector ($r < 1$ in the second column of each panel). The exceptions are Indonesia, where our finding of three cointegrating vectors suggests stationarity in the system, and Sri Lanka, where there may be two cointegrating vectors. In Table 3, when GDP appears in place of investment in the specification, we obtain similar results but the exception of Sri Lanka vanishes.

After testing for cointegration, we estimate VARs in levels and test for statistical causation between the financial variables and either investment or output. We can do this for eight of the countries because the Johansen tests identify a single cointegrating vector and thus support the use of standard Granger non-causality tests. We then estimate the VECM representation, which explicitly embeds the estimated long-run relationship as a regressor. We apply the Toda and Yamamoto (1995) methodology for Indonesia and Sri Lanka, where Table 2 shows that the number of cointegrating vectors is unclear. [9]

Table 4 summarizes our findings for the systems with investment. The levels VARs in the left-hand panel show the Granger non-causality results. For example, the significant effect of $M2 - M1$ in Eq. (1a) for India (rightmost column of the first panel) indicates statistical causation from $M2 - M1$ to investment. A lack of joint significance for lags of investment in Eq. (1c), where $M2 - M1$ is the dependent variable, suggests that the relationship is uni-directional. For the other countries, the Granger non-causality tests for the levels VARs show $M2 - M1$ leading investment

[8] In fact, Table 1 shows that the two tests in levels lead to different inferences in only 4 out of 40 cases. In three of these exceptions, the ADF test rejects the null of non-stationarity while the PP test does not. This is consistent with Schwert's (1989) finding that ADF tests tend to over-reject the null when lag lengths are based upon the AIC criterion. The sensitivity of the ADF tests to lag length selection makes the PP test particularly important as an additional tool for drawing inferences about unit roots.

[9] Pesaran et al. (2001) propose a bounds test that is useful for determining if a VAR in levels is appropriate, regardless of whether the regressors are $I(0)$ or $I(1)$. We ran these tests for our VAR systems and rejected the null hypothesis (i.e., that there is no relationship in levels) in at least one equation for 9 of our 10 systems involving output as the dependent variable and 7 of 10 systems with investment as the dependent variable. In many cases, the tests yielded statistics in the "inconclusive" range, however. Given what is known about the power of this test (Pesaran et al., 2001, pp. 304–306), we take this as additional confirmation of the appropriateness of our levels specifications.

Table 1
Unit root test statistics

Country	Period of study	ADF statistic		PP statistic	
		Level	First difference	Level	First difference
India	1950–2000				
I		−2.568	−6.482***	−2.853	−4.843***
GDP		−0.946	−5.320***	−1.858	−11.438***
$M1$		−0.422	−5.160***	−2.123	−7.111***
$M2-M1$		−2.411	−4.045**	−2.184	−5.693***
Indonesia	1965–2000				
I		−0.567	−3.977**	−2.106	−6.018***
GDP		−2.914	−4.341**	−2.515	−4.999***
$M1$		−2.841	−5.292***	−2.274	−7.286***
$M2-M1$		−1.896	−3.957**	−1.764	−8.378***
Japan	1955–2000				
I		−2.869	−2.805	−3.010	−4.836***
GDP		−2.503	−2.801	−1.672	−4.886***
$M1$		−2.720	−3.192*	−2.094	−4.647***
$M2-M1$		−2.001	−3.312*	−2.835	−4.240***
Korea	1953–2000				
I		−0.544	−3.594**	−0.852	−5.494***
GDP		−1.641	−3.795**	−2.575	−8.291***
$M1$		−2.121	−5.298***	−2.253	−6.428***
$M2-M1$		−2.297	−2.745	−1.345	−6.927***
Malaysia	1955–2000				
I		−3.830**	−4.908***	−2.234	−4.117**
GDP		−2.337	−5.160***	−3.621**	−6.278***
$M1$		−2.435	−5.906***	−2.364	−7.130***
$M2-M1$		−1.667	−5.610***	−2.130	−5.470***
Pakistan	1953–2000				
I		−0.968	−5.156***	−1.376	−7.102***
GDP		−2.039	−6.228***	−2.191	−7.686***
$M1$		−3.118	−6.317***	−2.966	−6.789***
$M2-M1$		−1.525	−6.088***	−1.816	−6.438***
Philippines	1950–2000				
I		−2.104	−5.505***	−1.725	−5.868***
GDP		−2.048	−4.393***	−2.231	−6.468***
$M1$		−1.896	−6.836***	−2.426	−8.974***
$M2-M1$		−3.727**	−5.223***	−2.330	−6.363***
Singapore	1963–2000				
I		−1.868	−3.868**	−2.576	−3.725**
GDP		−1.975	−4.198***	−1.572	−4.205**
$M1$		−1.266	−5.847***	−2.174	−7.055***
$M2-M1$		−4.015**	−4.376***	−2.279	−4.321***
Sri Lanka	1950–2000				
I		−2.512	−3.515**	−2.192	−4.748***
GDP		−1.840	−4.526***	−1.886	−6.347***
$M1$		−2.318	−6.223***	−2.773	−5.772***
$M2-M1$		−2.349	−3.548**	−2.375	−6.159***

(*continued on next page*)

Table 1 (*continued*)

Country	Period of study	ADF statistic		PP statistic	
		Level	First difference	Level	First difference
Thailand	1953–2000				
I		−3.052	−4.146**	−1.697	−3.518**
GDP		−2.924	−4.276***	−2.586	−4.102**
*M*1		−1.047	−5.559***	−0.902	−7.114***
*M*2 − *M*1		−0.791	−4.907***	−1.332	−5.280***

Note: *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels respectively.

Table 2
Johansen test statistics for cointegration between the real per capita log level of fixed investment (*I*), *M*1, and *M*2 − *M*1

Country	Maximum eigenvalue			Trace			Cointegrating vector [*I M*1 *M*2 − *M*1]
	$r = 0$	$r < 1$	$r < 2$	$r = 0$	$r < 1$	$r < 2$	
India	14.60*	10.09	0.17	24.86*	10.26	0.17	[1 −0.480 −0.341]
Indonesia	41.38*	11.83*	3.61*	56.81*	15.43*	3.61*	Stationary
Japan	14.68*	2.98	0.33	18.00*	3.32	0.33	[1 −25.939 7.836]
Korea	20.20*	4.92	2.68	27.80*	7.60	2.68	[1 −1.283 −0.060]
Malaysia	24.33*	7.44	0.31	32.08*	7.75	0.31	[1 −0.300 −0.517]
Pakistan	26.86*	9.12	4.57	40.55*	13.70	4.57	[1 −1.712 0.503]
Philippines	14.67*	5.09	1.80	21.55*	6.89	1.80	[1 0.661 −0.722]
Singapore	17.28*	6.13	0.24	23.65	6.37	0.24	[1 −3.063 0.959]
Sri Lanka	17.12*	11.05*	0.65	28.83*	11.70*	0.65	[1 −1.472 −0.312]
							[1 1.181 −1.026]
Thailand	18.36*	10.24	1.05	29.65*	11.29	1.05	[1 −0.225 −0.487]

Note: Each system includes logs of real per capita gross fixed investment, *M*1 and *M*2 − *M*1. The lag length is determined by nested likelihood ratio tests. The column labeled $r = 0$ tests a null of no cointegration, while the $r < 1$ ($r < 2$) columns test a null of at most one(two) cointegrating vectors. Asterisks represent rejections of the null hypothesis at 5% level. The normalized first cointegrating vectors appear in the rightmost column. For Sri Lanka, we report the two cointegrating vectors as implied by the Johansen test.

with no reverse causality for six countries—Japan, Korea, Malaysia, Pakistan, Sri Lanka, and Thailand. For two other countries, the Philippines and Singapore, we also find evidence of finance led investment, but feedback from investment to finance is apparent. Only for Indonesia are the findings inconclusive.

Our VECM models (right-hand panel of Table 4) support a weakly exogenous role of finance on investment in five out of nine countries—India, Malaysia, Pakistan, Sri Lanka, and Thailand. For example, in India we find a negative and significant effect at the 1% level for the error correction term in Eq. (2a) of the VECM, where the change in investment is the dependent variable. This, together with the negative coefficient on *M*2 − *M*1 in the cointegrating vector, indicates that a decrease in the value of stationary combination, which includes any effect generated by an increase in *M*2 − *M*1, will produce an upward adjustment in investment. Fur-

Table 3
Johansen test statistics for cointegration between the real per capita log level of output (GDP), $M1$, and $M2-M1$

Country	Maximum eigenvalue			Trace			Cointegrating vector [GDP $M1$ $M2-M1$]
	$r=0$	$r<1$	$r<2$	$r=0$	$r<1$	$r<2$	
India	17.11*	8.12	0.22	25.44*	8.33	0.22	[1 −0.840 −0.081]
Indonesia	55.41*	13.94*	3.06*	72.40*	17.00*	3.06*	Stationary
Japan	22.26*	4.47	0.06	26.79*	4.53	0.06	[1 −0.701 −0.289]
Korea	18.43*	7.18	0.94	26.55*	8.12	0.94	[1 −1.322 0.151]
Malaysia	23.63*	8.18	0.13	31.94*	8.31	0.13	[1 −0.343 −0.245]
Pakistan	17.11*	9.56	2.51	29.18*	12.07	2.51	[1 −0.965 −0.032]
Philippines	15.34*	6.63	1.38	23.34	8.00	1.38	[1 −1.457 0.694]
Singapore	25.86*	7.01	1.23	34.10*	8.24	1.23	[1 −0.940 −0.123]
Sri Lanka	31.85*	8.81	0.00	40.67*	8.81	0.00	[1 −2.632 0.274]
Thailand	14.63*	9.93	0.99	25.56	10.93	0.99	[1 −0.215 −0.354]

See note for Table 2. In this case, the logs of real per capita GDP replace investment in the tri-variate systems.

ther, the coefficient on the error correction term is not significant in Eq. (2c), where the change in $M2-M1$ is the dependent variable. For the other four countries, the sign of the coefficient of $M2-M1$ in the cointegrating vector, together with the sign of the error correction term in Eq. (2a), also suggest that an increase in $M2-M1$ induces an upward adjustment in investment.

In Table 5, we report our findings for VARs and VECMs that include output in place of investment as the measure of real sector performance. In these cases, we find Granger causality from $M2-M1$ to output without reverse causality for only five countries (e.g., India, Japan, Korea, Malaysia and Thailand). For Indonesia, we find that finance led output, but there is also feedback from output to finance. In the long run, a weakly exogenous role for finance is found for India, Malaysia Singapore, Sri Lanka, and Thailand.

Overall, the results show a link from finance to investment that is strikingly robust, with a uni-directional or bi-directional link in all but one country. Evidence for a causal link from finance to output is weaker.

In Table 6, we consider the percent of the variation in investment and output that can be attributed to the $M2-M1$ aggregate with variance decompositions. These decompositions use the same specifications as those in the VAR systems reported in Tables 4 and 5. When we place $M2-M1$ first, $M1$ second and investment last (upper panel of Table 6) we find that finance explains more than 5% of the variance at 3, 6, and 10-year horizons in all but one case (Indonesia at 3 years). The same is true when output is the measure of real activity, but this time Japan at a 10-year horizon is the only instance in which less than 5% of the variance is explained. More than 20% of the variance is explained in 18 of 30 cases for the investment systems and 21 cases for the systems with output.

We order $M2-M1$ first in the variance decomposition because our Granger causality tests suggest that finance behaves most exogenously among the variables in our tri-variate systems. Recent theory on the finance-growth relationship, such as

Table 4
Error correction and VAR estimates for systems with gross domestic fixed investment, $M1$, and $M2 - M1$

Country	Levels VAR Granger tests/MWALD tests					Error correction model		
	Eq.	I	$M1$	$M2 - M1$	R^2	Eq.	ECT	R^2
India								
[1 −0.480 −0.341]	(1a)	0.663(0.000)	0.130(0.834)	0.135(0.063)**	0.989	(2a)	−0.581(0.002)***	0.404
$k = 3$	(1b)	−0.080(0.008)***	0.992(0.000)	0.060(0.156)	0.965	(2b)	0.294(0.269)	0.394
	(1c)	0.036(0.524)	−0.057(0.340)	0.986(0.000)	0.993	(2c)	−0.091(0.810)	0.119
Indonesia								
NA	(1a)	0.505(0.043)	0.450(0.102)	0.015(0.827)	0.989	(2a)		
$k = 2$	(1b)	0.072(0.851)	0.553(0.085)	0.087(0.528)	0.983	(2b)	NA	
	(1c)	−0.277(0.642)	−0.057(0.857)	0.823(0.000)	0.990	(2c)		
Japan								
[1 −25.939 7.836]	(1a)	0.943(0.000)	−0.064(0.017)**	0.073(0.002)***	0.990	(2a)	0.001(0.350)	0.629
$k = 2$	(1b)	0.014(0.508)	0.866(0.000)	0.057(0.390)	0.992	(2b)	0.003(0.046)**	0.245
	(1c)	0.012(0.273)	−0.094(0.410)	1.016(0.000)	0.998	(2c)	0.004(0.001)***	0.672
Korea								
[1 −1.283 −0.060]	(1a)	0.862(0.000)	0.090(0.178)	0.039(0.007)***	0.995	(2a)	−0.043(0.698)	0.319
$k = 2$	(1b)	0.165(0.013)**	0.647(0.000)	0.057(0.007)***	0.990	(2b)	0.268(0.020)**	0.278
	(1c)	0.563(0.434)	−0.579(0.645)	0.879(0.000)	0.992	(2c)	0.517(0.018)**	0.213
Malaysia								
[1 −0.300 −0.517]	(1a)	0.608(0.000)	−0.002(0.084)*	0.266(0.002)***	0.984	(2a)	−0.437(0.002)***	0.437
$k = 2$	(1b)	−0.015(0.133)	0.818(0.000)	0.110(0.052)*	0.972	(2b)	−0.038(0.739)	0.030
	(1c)	0.072(0.415)	−0.023(0.460)	0.958(0.000)	0.998	(2c)	0.006(0.907)	0.126
Pakistan								
[1 −1.712 0.503]	(1a)	0.632(0.000)	0.438(0.008)***	0.078(0.072)*	0.971	(2a)	0.300(0.008)***	0.364
$k = 3$	(1b)	0.034(0.458)	0.719(0.000)	0.119(0.089)*	0.937	(2b)	0.084(0.567)	0.213
	(1c)	−0.048(0.165)	0.286(0.205)	0.757(0.000)	0.958	(2c)	−0.258(0.117)	0.278
Philippines								
[1 0.661 −0.722]	(1a)	0.915(0.000)	−0.051(0.700)	0.006(0.070)*	0.921	(2a)	0.010(0.882)	0.068
$k = 2$	(1b)	−0.147(0.804)	0.772(0.000)	0.089(0.505)	0.619	(2b)	−0.115(0.047)**	0.138
	(1c)	0.052(0.091)*	−0.153(0.540)	0.953(0.000)	0.983	(2c)	0.073(0.242)	0.073

Singapore								
[1 −3.063 0.959]	(1a)	0.783(0.000)	0.431(0.393)	−0.098(0.032)**	0.988	(2a)	0.200(0.029)**	0.505
$k = 3$	(1b)	0.100(0.557)	0.457(0.000)	0.204(0.302)	0.982	(2b)	0.108(0.169)	0.278
	(1c)	−0.140(0.078)*	0.382(0.309)	0.877(0.000)	0.994	(2c)	−0.157(0.044)**	0.310
Sri Lanka								
[1 −1.472 −0.312]	(1a)	0.722(0.000)	0.238(0.405)	0.124(0.060)*	0.984	(2a)	−0.213(0.024)**	0.283
$k = 2$	(1b)	0.106(0.321)	0.640(0.000)	0.017(0.921)	0.945	(2b)	0.183(0.001)***	0.174
	(1c)	0.196(0.148)	−0.079(0.783)	0.871(0.000)	0.988	(2c)	0.117(0.328)	0.093
Thailand								
[1 −0.225 −0.487]	(1a)	0.681(0.000)	0.039(0.047)**	0.154(0.008)***	0.992	(2a)	−0.239(0.006)***	0.458
$k = 2$	(1b)	−0.087(0.003)***	0.949(0.000)	0.069(0.330)	0.957	(2b)	−0.016(0.855)	0.145
	(1c)	0.065(0.609)	−0.070(0.680)	0.959(0.000)	0.998	(2c)	0.017(0.823)	0.105

Note: The systems include I, $M1$, and $M2 - M1$, all in real per capita log levels. Estimates of the normalized cointegrating vectors appear beneath the country names. The equation numbers correspond to those in the text with (a), (b), and (c) using I, $M1$, and $M2 - M1$ as the respective dependent variables. The left panel reports the sum of the regression coefficients on I, $M1$, and $M2 - M1$ in levels VARs with the significance level of the F-test for Granger non-causality in parentheses. The right panel reports the coefficient on the error correction term (ECT) in each equation with significance levels in parentheses. The lag lengths (k), given beneath the normalized cointegrating vectors, are determined by nested likelihood ratio tests. The VECMs use ($k - 1$) lags in the first difference. For Indonesia and Sri Lanka, we apply Toda and Yamamoto's MWALD test and the numbers in parentheses are the p-values of the MWALD tests.

Table 5
Error correction and VAR estimates for systems with gross domestic product, $M1$, and $M2-M1$

Country	Levels VAR Granger tests/Mwald tests					Error correction model		
	Eq.	GDP	$M1$	$M2-M1$	R^2	Eq.	ECT	R^2
India								
[1 −0.840 −0.081]	(1a)	0.444(0.000)	0.439(0.017)**	0.057(0.048)**	0.982	(2a)	−0.581(0.002)***	0.499
$k=3$	(1b)	0.376(0.261)	0.612(0.000)	0.005(0.156)	0.957	(2b)	0.294(0.269)	0.283
	(1c)	−0.158(0.913)	0.096(0.340)	1.010(0.000)	0.992	(2c)	−0.091(0.810)	0.116
Indonesia								
NA	(1a)	0.999(0.001)	0.009(0.446)	0.017(0.082)*	0.994	(2a)		
$k=2$	(1b)	0.263(0.823)	0.473(0.073)	0.097(0.074)*	0.984	(2b)	NA	
	(1c)	1.657(0.066)*	−0.847(0.325)	0.686(0.000)	0.995	(2c)		
Japan								
[1 −0.701 −0.289]	(1a)	1.010(0.000)	−0.080(0.009)***	0.028(0.007)***	0.998	(2a)	−0.139(0.021)**	0.667
$k=2$	(1b)	−0.024(0.640)	0.902(0.000)	0.063(0.390)	0.992	(2b)	0.134(0.230)	0.211
	(1c)	0.405(0.718)	−0.253(0.410)	0.871(0.000)	0.998	(2c)	0.306(0.00)***	0.695
Korea								
[1 −1.322 0.151]	(1a)	0.861(0.000)	0.076(0.074)*	0.033(0.000)***	0.997	(2a)	−0.077(0.260)	0.413
$k=2$	(1b)	0.277(0.365)	0.498(0.000)	0.110(0.008)***	0.990	(2b)	0.351(0.006)***	0.266
	(1c)	0.437(0.304)	−0.586(0.645)	1.058(0.000)	0.992	(2c)	0.481(0.035)**	0.241
Malaysia								
[1 −0.343 −0.245]	(1a)	0.266(0.000)	0.210(0.140)	0.201(0.048)**	0.989	(2a)	−0.833(0.002)***	0.306
$k=2$	(1b)	0.124(0.057)*	0.774(0.000)	0.070(0.052)*	0.972	(2b)	−0.132(0.800)	0.036
	(1c)	0.252(0.709)	−0.076(0.460)	0.929(0.000)	0.998	(2c)	−0.120(0.802)	0.091
Pakistan								
[1 −0.965 −0.032]	(1a)	0.364(0.000)	0.415(0.388)	0.122(0.263)	0.981	(2a)	−0.422(0.102)	0.227
$k=3$	(1b)	−0.257(0.072)*	0.956(0.000)	0.160(0.089)*	0.965	(2b)	0.136(0.704)	0.294
	(1c)	−0.232(0.075)*	0.135(0.205)	1.023(0.000)	0.981	(2c)	−0.286(0.508)	0.282
Philippines								
[1 −1.457 0.694]	(1a)	0.879(0.000)	−0.008(0.018)**	0.008(0.508)	0.962	(2a)	0.020(0.007)***	0.261
$k=2$	(1b)	−0.301(0.568)	0.784(0.000)	0.083(0.505)	0.614	(2b)	−0.007(0.713)	0.069
	(1c)	−0.090(0.522)	−0.111(0.540)	0.986(0.000)	0.984	(2c)	−0.033(0.099)*	0.108

Singapore								
[1 −0.940 −0.123]	(1a)	0.586(0.000)	0.243(0.524)	0.123(0.134)	0.996	(2a)	−0.379(0.034)**	0.464
$k = 2$	(1b)	0.210(0.092)*	0.448(0.000)	0.050(0.050)**	0.980	(2b)	0.336(0.332)	0.194
	(1c)	−0.300(0.941)	−0.248(0.686)	0.986(0.000)	0.993	(2c)	0.111(0.746)	0.265
Sri Lanka								
[1 −2.632 0.274]	(1a)	1.077(0.000)	−0.224(0.009)***	0.028(0.391)	0.995	(2a)	0.088(0.001)***	0.268
$k = 2$	(1b)	0.352(0.000)***	0.405(0.000)	0.001(0.021)**	0.956	(2b)	0.195(0.000)***	0.328
	(1c)	0.367(0.033)**	−0.143(0.760)	0.863(0.000)	0.989	(2c)	−0.024(0.783)	0.064
Thailand								
[1 −0.215 −0.354]	(1a)	0.867(0.000)	−0.024(0.024)**	0.051(0.035)**	0.996	(2a)	−0.115(0.033)**	0.289
$k = 2$	(1b)	−0.017(0.098)*	0.930(0.000)	0.036(0.330)	0.949	(2b)	−0.123(0.316)	0.058
	(1c)	0.198(0.362)	−0.147(0.680)	0.938(0.000)	0.998	(2c)	0.189(0.141)	0.191

See note for Table 4. In this case, the logs of real per capita GDP replace the logs of real per capita investment in the tri-variate systems. Toda and Yamamoto's MWALD test is applied for Indonesia.

Table 6
Variance decompositions (percent of variance explained by $M2 - M1$)

Country	Decomposition of *I*			Decomposition of GDP		
	3 years	6 years	10 years	3 years	6 years	10 years
Variable ordering: M2 − M1, M1, I or DP						
India	21.506	42.673	67.296	24.011	27.991	38.399
Indonesia	3.700	8.802	18.311	17.396	20.486	22.453
Japan	26.243	38.536	37.666	15.780	11.903	3.566
Korea	31.327	40.425	44.653	20.570	34.758	50.380
Malaysia	32.375	43.027	49.879	53.591	63.445	71.494
Pakistan	25.707	19.107	27.144	38.077	46.497	63.688
Philippines	11.104	9.728	9.503	20.849	22.825	26.258
Singapore	12.169	17.536	16.814	29.361	55.946	72.134
Sri Lanka	50.634	60.257	63.826	7.647	5.355	8.798
Thailand	11.561	17.243	26.210	3.305	8.596	21.631
Variable ordering: I or GDP, M1, M2 − M1						
India	0.129	15.228	33.546	2.763	3.033	7.546
Indonesia	0.079	3.887	15.976	0.145	0.845	1.344
Japan	15.467	32.730	44.990	6.394	10.568	7.800
Korea	12.971	15.831	16.350	26.421	50.792	69.965
Malaysia	2.603	15.757	24.382	10.868	17.828	24.495
Pakistan	6.271	7.787	8.620	2.181	9.008	28.248
Philippines	1.180	1.250	1.073	1.227	1.051	2.165
Singapore	2.339	5.932	5.902	10.003	32.061	46.606
Sri Lanka	4.345	7.206	9.087	0.159	1.682	5.271
Thailand	1.657	10.906	15.910	0.308	3.352	10.574

Note: The table shows the percent of investment and output attributable to the $M2 - M1$ financial variable in the tri-variate VAR systems at the lag length selected earlier. The time horizons are set at 3, 6, and 10 years. In the upper panel, we place the $M2 - M1$ variable first, and the measure of real activity third. We reverse this ordering in the lower panel.

Bencivenga and Smith (1991), present mechanisms through which finance leads the real sector and are thus consistent with this choice. Placing $M2 - M1$ first, however, allows the largest possible effect of finance on the real sector to emerge. When we reverse the ordering to place $M2 - M1$ last, our results are weaker, as would be expected. Nevertheless, 20 of the 30 investment systems still have $M2 - M1$ explain more than 5% of the variance. This occurs in 17 cases for the systems with output as well. Overall, the variance decompositions confirm our findings that finance matters for investment and output.

4. Robustness

In this section we check the robustness of our results to the inclusion of credit allocated to private sector (CPV) as the measure of financial development in the systems with investment as the measure of macroeconomic performance.

Unit root tests cannot reject non-stationary for CPV, and in most cases the cointegration tests identify a single cointegrating vector. However, there are

Table 7
Error correction and VAR estimates for systems with gross domestic fixed investment, $M1$, and CPV

Country	Levels VAR Granger tests/MWALD tests					Error correction model		
	Eq.	I	$M1$	CPV	R^2	Eq.	ECT	R^2
India								
[1 −0.522 −0.401]	(1a)	0.610(0.000)	0.204(0.833)	0.176(0.045)**	0.989	(2a)	−0.293(0.003)***	0.453
$k = 3$	(1b)	−0.060(0.008)***	1.026(0.000)	0.051(0.042)**	0.964	(2b)	0.062(0.513)	0.408
	(1c)	−0.097(0.296)	−0.025(0.758)	1.055(0.000)	0.994	(2c)	−0.118(0.269)	0.257
Indonesia								
[1 −1.264 −0.005]	(1a)	0.950(0.000)	0.003(0.066)*	0.003(0.102)	0.991	(2a)	0.019(0.945)	0.489
$k = 3$	(1b)	0.801(0.044)**	−0.642(0.000)	0.054(0.011)**	0.988	(2b)	0.913(0.003)***	0.499
	(1c)	1.452(0.340)	−1.347(0.049)**	0.719(0.000)	0.974	(2c)	1.247(0.097)*	0.461
Japan								
[1 4.346 −2.715]	(1a)	0.469(0.000)	−0.136(0.016)**	0.086(0.583)	0.989	(2a)	−0.040(0.000)***	0.591
$k = 3$	(1b)	−0.027(0.830)	0.847(0.000)	0.109(0.222)	0.993	(2b)	−0.025(0.014)**	0.396
	(1c)	0.121(0.209)	−0.227(0.153)	1.030(0.000)	0.991	(2c)	−0.034(0.033)**	0.363
Korea								
NA	(1a)	0.604(0.000)	−0.139(0.023)**	0.387(0.014)**	0.997	(2a)		
$k = 4$	(1b)	0.203(0.287)	0.280(0.001)	0.244(0.227)	0.991	(2b)	NA	
	(1c)	0.513(0.012)**	−0.428(0.006)***	0.820(0.000)	0.997	(2c)		
Malaysia								
[1 −0.247 −0.505]	(1a)	0.623(0.000)	−0.004(0.084)*	0.232(0.005)***	0.983	(2a)	−0.402(0.002)***	0.384
$k = 2$	(1b)	−0.024(0.133)	0.836(0.000)	0.095(0.093)*	0.974	(2b)	−0.033(0.761)	0.124
	(1c)	0.039(0.287)	0.029(0.321)	0.948(0.000)	0.997	(2c)	0.010(0.884)	0.166
Pakistan								
NA	(1a)	0.648(0.008)	0.072(0.609)	0.186(0.097)*	0.978	(2a)		
$k = 3$	(1b)	−0.169(0.566)	0.566(0.058)	0.374(0.551)	0.941	(2b)	NA	
	(1c)	−0.111(0.848)	0.108(0.799)	0.887(0.352)	0.954	(2c)		
Philippines								
[1 4.521 −2.114]	(1a)	1.021(0.000)	0.244(0.545)	0.122(0.034)**	0.935	(2a)	−0.004(0.000)***	0.352
$k = 3$	(1b)	0.017(0.963)	0.941(0.000)	−0.035(0.951)	0.583	(2b)	0.012(0.543)	0.120
	(1c)	0.261(0.019)**	0.391(0.242)	0.745(0.000)	0.883	(2c)	0.089(0.040)**	0.322

Table 7 (*continued*)

Country	Levels VAR Granger tests/MWALD tests					Error correction model		
	Eq.	I	$M1$	CPV	R^2	Eq.	ECT	R^2
Singapore								
[1 −3.053 0.998]	(1a)	0.869(0.000)	0.333(0.293)	−0.111(0.406)	0.988	(2a)	0.139(0.017)**	0.461
$k = 2$	(1b)	0.082(0.612)	0.725(0.000)	0.077(0.065)*	0.984	(2b)	−0.064(0.160)	0.348
	(1c)	0.136(0.001)***	0.287(0.123)	0.716(0.000)	0.997	(2c)	−0.009(0.807)	0.509
Sri Lanka								
[1 −1.942 −0.225]	(1a)	0.678(0.000)	0.180(0.048)**	0.198(0.000)***	0.987	(2a)	−0.151(0.042)**	0.339
$k = 2$	(1b)	0.042(0.009)***	0.632(0.000)	0.074(0.004)***	0.947	(2b)	0.153(0.008)	0.185
	(1c)	−0.068(0.216)	−0.137(0.248)	1.078(0.000)	0.99	(2c)	0.034(0.662)	0.090
Thailand								
NA	(1a)	0.848(0.000)	−0.300(0.469)	0.145(0.171)	0.993	(2a)		
$k = 2$	(1b)	−0.158(0.053)*	0.787(0.000)	0.161(0.488)	0.962	(2b)	NA	
	(1c)	0.171(0.020)**	−0.099(0.530)	0.915(0.000)	0.998	(2c)		

See note for Table 4. In this case, the logs of real per capita CPV replace the logs of real per capita $M2 - M1$ in the tri-variate systems. For Korea, Pakistan, and Thailand, we apply Toda and Yamamoto's MWALD tests and the figures in parentheses are the p-values of these tests.

still some cases in which we find no cointergration or multiple cointegrating vectors. [10]

The VAR results, shown in Table 7, indicate a uni-directional relationship or bi-directional relationship from finance to investment in 6 out of 10 countries (e.g., India, Korea, Malaysia, Pakistan, Philippines, and Sri Lanka), while tests on the ECT indicate a weakly exogenous role for finance on investment in 4 out of 7 countries (e.g., India, Malaysia, Singapore, and Sri Lanka). The results are slightly weaker than those obtained with $M2 - M1$ as the measure of financial development, yet on the whole still support a role for financial factors in promoting factor accumulation through investment. [11]

5. Conclusion

In this study we took a time series approach to examining links between financial development and real economic performance for 10 Asian countries over the past half-century. Our results to some extent confirm those of Demetriades and Hussein (1996)—namely that the nature of the finance–growth nexus varies considerably across countries. Nevertheless, we can more clearly say that (1) in nearly all cases, financial development leads investment, and (2) cases of uni-directional reverse causality from economic performance to the financial sector are rare. This suggests that investment may indeed be the key channel through which financial development affected growth in the emerging economies that we have considered, and may have broader implications for other countries in the earlier stages of market development. We consider the further investigation of the finance–investment link for other nations and periods in history to be an important part of the macroeconomic research agenda.

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[10] We find no cointegrating vector for Thailand, and three cointegrating vectors for Korea and Pakistan.

[11] We also conducted our tests with CPV and output as the measure of economic performance and obtained results that were qualitatively similar to those with $M2 - M1$.

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