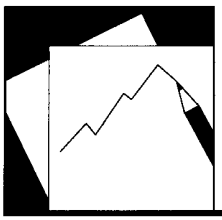
WP/10/110



IMF Working Paper

Public Investment as a Fiscal Stimulus: Evidence from Japan's Regional Spending During the 1990s

Markus Brückner and Anita Tuladhar

INTERNATIONAL MONETARY FUND

 WP/10/110

IMF Working Paper

Fiscal Affairs Department

Public Investment as a Fiscal Stimulus: Evidence from Japan's Regional Spending During the 1990s

Prepared by Markus Brückner and Anita Tuladhar[1]

Authorized for distribution by Benedict Clements

April 2010

Abstract

How effective was public investment in stimulating the Japanese economy during the economic stagnation of the 1990s? Using a dataset of regional public investment spending, we find that investment multipliers were higher than for public consumption, although they were relatively low and declining over time. The paper also finds that the effectiveness of economic infrastructure investment, implemented mainly by the central government, is lower than that of social investment mostly undertaken by local governments. These results suggest that while public investment may yield higher output effects than other spending, its effectiveness depends upon its composition, the level of government implementation, and supply side factors.

JEL Classification Numbers: E62, H30

Keywords: Fiscal policy, fiscal multipliers

Authors' E-Mail Addresses: atuladhar@imf.org; mbruckner@upf.edu

[1] The authors are grateful to Fabio Canova, Benedict Clements, Carlo Cottarelli, Jordi Gali, Robert Gillingham, Makoto Nakagawa, Rolando Ossowski, Evi Pappa, Antonio Spilimbergo, Kiichi Tokuoka, and participants at an FAD seminar for their useful comments; Keiko Takahashi for her invaluable assistance in compiling the data; and to Maria Delgado Coelho for excellent research assistance. We also thank Inessa Love for sharing her panel VAR program. Remaining errors are the authors' responsibility.

Contents Page

Appendices

Appendix Tables

I. INTRODUCTION

The financial crisis of 2008/09 and national governments' endeavors to stimulate the economy have rekindled interest in the Japanese experience with fiscal stimulus plans. Many elements of the Japanese crisis and fiscal stimulus responses have similarities to today's ongoing economic crisis. During the 1990s, a period frequently referred to as the "lost decade," economic growth in Japan declined sharply to an average of 1.2 percent from an average growth rate of 3.9 percent in the decade earlier. The economic slowdown was precipitated by a bursting of the asset and credit bubble as the stock market declined by 41 percent and credit flow declined by 71 percent between 1989 and 1991. In response, the Japanese government introduced numerous stimulus packages, which were continued over the course of the decade. Yet, despite large and repeated fiscal stimulus packages, the cost effectiveness of these packages is questionable. Growth remained stagnant amidst deflationary pressures. At the same time, public deficits and debts rose rapidly, reflecting both tax revenue slowdown and the stimulus packages.

With the onset of the global economic crisis, governments have adopted stimulus packages to rejuvenate their economies. To maximize the effectiveness of these packages, many countries have sought timely, targeted, and temporary policy measures. In this context, spending measures, particularly in public investment and transfers to the unemployed, have been favored as they are deemed to have higher multipliers. Many emerging markets, in particular, have focused a large share of their stimulus plans on public investment. Yet, it is widely acknowledged that such projects are difficult to implement in a timely manner and, if not appropriately targeted, relatively ineffective in stimulating economic activity.

Against this background, this study seeks to examine the Japanese experience with the expenditure policy measures and draw on policy implications for maximizing the effectiveness of such measures. Given the focus of the stimulus packages on investment spending, we estimate the multiplier effect for public investment and compare it with that of other public spending. We further explore whether targeting of public investments was appropriate in maximizing output by examining the allocation of public investment across regions. Finally, we assess the long-run supply side impact of public spending on marginal productivity of capital and examine its relation with the size of multipliers over time.

These issues have been studied in the literature to a certain degree. This paper differs from these studies in three aspects. First, we use prefectural level data on total public investment as well as local government expenditures to calculate the multiplier. Local governments play an important role in Japan as they comprise 60 percent of spending and an even larger share of public investment. About 80 percent of public works projects were implemented by local governments and about 65 percent financed by local governments during the nineties. The availability of a richer dataset allows us to explore various dimensions of fiscal policy including the different types of spending and regional allocation during the nineties. Secondly, we use Generalized Method of Moments (GMM) to estimate the multiplier effects,

which allows us to obtain consistent estimates even if government expenditures are affected on impact by changes in the economic environment. Finally, by extending the analysis of the marginal productivity of capital beyond the so-called "lost decade," we complement the analysis of multiplier effects with the longer-term productivity of public investment spending.

The paper is organized as follows. Section II provides a background on the fiscal stimulus packages and a review of the literature on the effectiveness of public investment spending in Japan. Section III describes the empirical strategy and the data. Section IV presents the results on the estimation of multiplier effects of public investment spending. Section V assesses in further detail the possible reasons for the size of the multipliers with a focus on crowding out effects, allocation of public investment across regions, and the marginal productivity of capital. Section VI concludes.

II. BACKGROUND

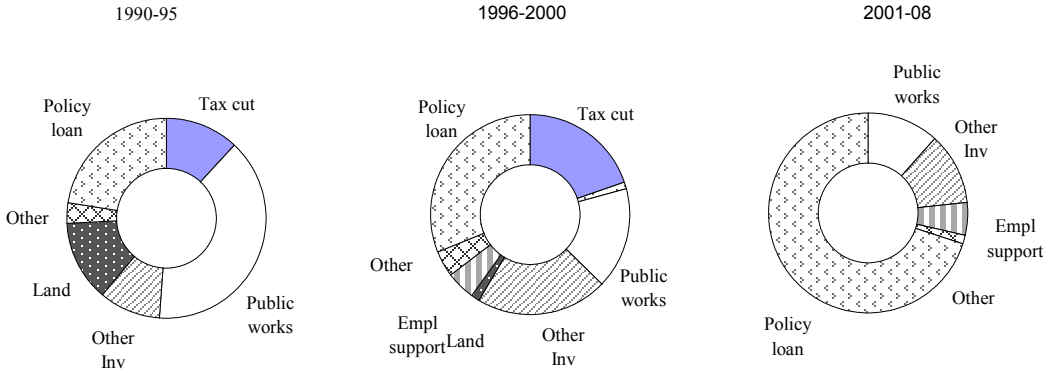
A. Fiscal Stimulus Packages: Size and Composition

The Japanese government introduced numerous fiscal stimulus packages—fifteen spending packages in total between 1990 and 2008—to address the economic impact of the financial crisis and the slowdown in growth. The key components of the packages (about 28 percent of GDP in total), included:

- public works and social infrastructure related projects, including land acquisition (14.2 percent of 2000 GDP);
- credit guarantees and augmentation of credit lines to banks for loans to small and medium-sized enterprises and for the housing sector (8.5 percent of GDP);
- employment assistance and cash transfers (2.1 percent of GDP); and
- tax measures (3.3 percent of GDP).

Appendix Table 8 provides details of the stimulus packages implemented between 1990 and 2008. Public works projects and land acquisition constituted the main component of the stimulus packages in the early part of the decade, comprising nearly half of the total stimulus spending (Figure 1). The stimulus packages were introduced through supplementary budgets at the level of both the central and local governments. A large share of public works programs were financed by local governments in the early nineties. However, this share declined over time due to financing difficulties experienced by the local governments. Public investment also moved away from public works in the second half of the nineties towards other sectors such as science and technology and education. Similarly, land purchases by the government, which constituted an important part of the stimulus package in the early half of the decade, were later abandoned due to low productivity.

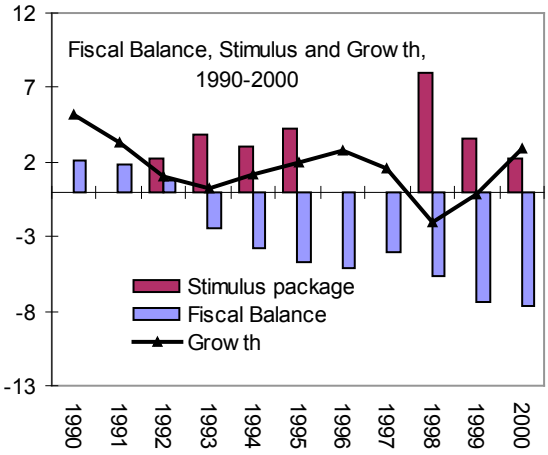
Figure 1. Japan: Composition of Stimulus Packages, 1990–2008



Source: Nakagawa (2009).

Policy loans, including credit guarantees, played a more prominent role later in the decade and in the recent financial crisis.[2] Cash transfers through employment support, social security spending, and cash vouchers for households accounted for a relatively small share of the stimulus package. Income tax cuts were first implemented in 1994, with a sunset clause and a VAT increase in 1997. However, following a sharp economic contraction in 1998, the income tax increase was quickly reversed and a series of temporary tax cuts were implemented (Figure 2).

Figure 2. Fiscal Balance, Stimulus and Growth,1990–2000

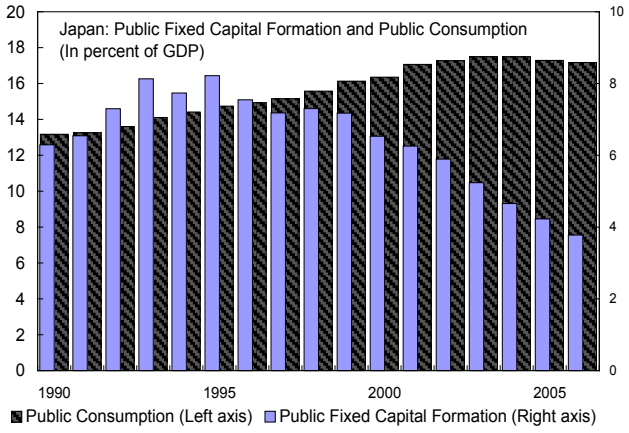


Source: Nakagaw a (2009); and WEO.

[2] The size of the policy loans in the stimulus plans reflects the planned augmentation of credit lines by the banks. As such, it overstates the budgetary allocation to increase capital of the lending agencies and the underlying subsidies. See IMF (2009) and Posen (2004) for a review of fiscal policy developments in Japan during the nineties.

It is important to note that contrary to the headline figures in the announced packages, actual fiscal stimulus was limited. The stimulus packages, which were included in the supplemental budgets, did not represent the actual fiscal stance because the initial budgets were usually contractionary when compared with the outturn in the previous year. Structural balances indeed deteriorated from a surplus of about 1/5 percent of GDP in 1990 to a deficit of 6 percent of GDP in 2000. But the main contributors to the increase in the fiscal deficit were declining taxes (3 percentage points) and increases in social security costs (3½ percentage points). The remaining 1 percent of GDP was due to government spending on land and capital transfers (Kalra, 2003). Public investment increased only between 1990 and 1995 and subsequently declined (Figure 3), as concerns about rising public debt led to retrenchment of public spending, particularly by the local government on self-financed projects.

Figure 3. Public Fixed Capital Formation and Public Consumption, 1990–2006



Source: National authorities.

B. Literature Review

There is an extensive empirical literature on the multiplier effect of fiscal policy in Japan. However, no consensus has emerged on the effectiveness of the fiscal policies during the nineties. Spending multiplier estimates using time series data have in general been smaller than those derived from model-based estimates. Estimates for the short-run multiplier, derived from VAR models have ranged from 0.4 (Matsuoka, 1996; and Kalra, 2003) to 0.7 (Bayoumi, 2000). However, Kuttner and Posen (2002) use a structural VAR model based on an identification strategy developed in Blanchard and Perotti (2002) and find a much higher spending multiplier—calculated as the cumulative impact on output after four years—of 2.0. A number of studies find that the fiscal multipliers have declined over time (OECD, 2000).

Several studies have also examined the impact of public investment spending on output in Japan. Most of these papers have used the VAR methodology and generally found low multiplier effects of public investment spending. Miyazaki (2007), using a structural VAR model, finds that public investment in construction has an insignificant impact contemporaneously on output, although central government investment has a persistent and positive impact over time. Ihori and others (2003), using non-structural VAR analysis, find that public investment marginally stimulates private consumption in the 1990s, but crowds out private investment more than in earlier decades. Afonso and Aubyn (2008) evaluate the macroeconomic effects of public and private investment through VAR analysis for

14 European Union countries plus Canada, Japan, and the United States, and find relatively low multiplier effects of public investment in Japan. Estimates based on macroeconomic models, however, find larger multiplier effects such as in Murata and Saito (2004). Hida and others (2008) update these estimates and find that the public investment multiplier peaks at 1.1 at a two-year horizon.

What explains the size of the spending multipliers?[3] Unfortunately, the literature on the size of or reasons for the multipliers is not conclusive. Several arguments have been presented for limited crowding out effects in Japan. Although gross government debt was high, net of assets, debt was low by industrial country standards. There was also no empirical evidence of the effect of government debt on the marginal propensity to consume (Bhattacharya, 1999). From a macro perspective, risks of default and inflation were contained as debt was held predominantly in the domestic market by long-term institutional investors. This was borne out by the low interest rates in Japan, suggesting a low risk premium. However, although short-term rates remained low, long-term interest rates increased, indicating some crowding out of private investment by public investment.

On the other hand, studies have also documented that fiscal expansion had a limited impact on private investment due to the credit crunch and the ensuing deleveraging by Japanese firms (Bayoumi, 2000). An appreciating yen also limited investment growth, and deleveraging in the construction sector offset the role of public works. Other structural factors also offset the effectiveness of fiscal expansion. Due to an aging population, there were composition effects of fiscal policy as rising old-age dependency led to a shift in spending towards social security payments, which has lower multiplier effects (even negative over the longer term).

Several studies have also examined the underlying reasons for low efficiency of public investment, with a focus on the regional allocation of public investment in Japan. Variables such as population, area size, and income, which reflect the scale and demand for public investment, are found to be significant for different types of investments (Kondoh, 2008; and Yoshino and Sakakibara, 2002). Allocation can also be affected by other policy objectives such as employment policy or the regional distribution of income. Yamano and Ohkawara (2000) find that public investment has not been allocated in accordance with marginal productivity and that public capital investment has been used as a policy tool for adjusting income inequality. Public investment has been focused on social infrastructure such as rural roads and agriculture, which have lower marginal productivity compared to larger urban-based projects.

[3] See Hemming and others (2002) for a review of the literature on the effectiveness of fiscal policy in stimulating economic activity. In this section, we focus the literature review on Japan.

Aside from the policy objectives, political economy also factors prominently in the literature. Kondoh (2008) finds that local special interest groups wield substantial influence in the process of budget formation and the allocation of public investment. Public investment policy in Japan is influenced by political incentives both in the central and local governments, and has often been utilized for different political purposes or used as a disguised income transfer to special interest groups. With the end of single party rule and the emergence of coalition government, the clout of the local interest groups has increased, particularly in the construction sector where public investment is concentrated. Doi (1995) argues that political economy factors have led to a higher allocation of public investment in rural areas than metropolitan areas, as rural areas are overrepresented in the Diet. In the following section, we estimate the impact of fiscal spending on output and examine some of these factors in explaining the size of the multiplier.

III. Empirical Strategy and Data

We use annual time-series data available at the prefecture level during the period 1990–2000. The dataset contains detailed data on the different components of public investment expenditure by the general government. This provides us with a unique opportunity to study the effect that different types of investment spending have had on economic activity. We complement this with data on public expenditures of the local governments at the prefecture level. For details on the data sources, please see Appendix II.

We use the following econometric model to estimate from within-prefecture variation the effect that fiscal policy has on regional output:

$$Y_{c,t} = a_c + d_t + p * F_{c,t} + D^T X_{c,t} + u_{c,t}$$

where $Y_{c,t}$ is value added of prefecture c in year t and $F_{c,t}$ is government expenditure of prefecture c in year t. $X_{c,t}$ is a vector of control variables varying at the prefecture-year level; a_c are unobserved, time-invariant prefecture fixed effects, and d_t are year-specific fixed effects. All variables are expressed in real per capita terms and are expressed as logs of the levels. The fiscal multiplier can be computed from the estimate of the elasticity parameter, p.[4]

One of the key advantages of our model is that it fully accounts for year-specific shocks, d_t. Accounting for these shocks is important because it allows us to take care of identification problems that arise due to changes in monetary policy. Because monetary policy affects economic activity in prefectures in a similar way, it will be fully accounted for by the

[4] To obtain the absolute effect on output for an increase in government expenditures (i.e. dY/dG), the elasticity estimates need to be multiplied by the inverse of the share of government expenditures in GDP. These shares are, respectively, 0.14 for local government expenditures and 0.12 for general government investment.

year-specific fixed effects. In contrast to standard VAR analysis, our estimates of elasticity will therefore be immune to biases that arise from inconsistent estimates of the effect that monetary policy has on economic output.

Our model also allows us to circumvent, to a certain degree, an endogeneity bias that is due to fiscal policy responding to changes in the economic environment. If government expenditures increase during times of recessions, it could introduce negative simultaneity bias between left-hand and right-hand side variables that downward biases the estimates on the elasticity. The year fixed effects would, however, capture the overall response of government expenditures to recessions. Any remaining downward bias would be reflected if fiscal policy is countercyclical at the prefecture level. Such a downward bias can be expected to be relatively small due to financing constraints on the prefecture budget, which would reduce the prefecture government's ability to run a countercyclical policy.[5]

We address remaining concerns of endogeneity bias by treating government expenditures as an endogenous regressor in the system Generalized Method of Moments (SYS-GMM) estimation (Blundell and Bond, 1998). The SYS-GMM estimator uses lagged first-differences of the government expenditure series as instruments for the equation in levels. The identifying assumption is thus made that past first-differences of prefecture government expenditures are not systematically correlated with contemporaneous surprise changes in the prefecture output. By controlling for lagged dependent variable, this condition is satisfied if prefecture governments were to base their current expenditures on future (prefecture) output forecasts.[6] We use cyclically adjusted fiscal variables, following the procedure outlined in Blanchard and Perotti (2002) to identify the effects of fiscal shocks on output.

IV. Results: Elasticity and Multiplier Estimates

A. Government Investment Elasticities

Table 1 presents our dynamic panel data estimates of the public investment elasticities, based on general government expenditures on public investment in a given prefecture and year. In column (1) we show the baseline estimates where the control variables are prefecture-specific fixed effects as well as year-specific fixed effects. The estimated coefficient on the government investment, measuring the elasticity of output with respect to government investment, is 0.05 and the estimate is statistically significant at the 1 percent level. In columns (2) and (3) we include as additional control variables tax revenues and public debt.

[5] This is likely reflected in the fact that the sample average of the local government deficit in GDP is less than 0.2 percent. The inter-quartile range of the local government deficit, as a share of GDP, is 0.1 percent to 0.3 percent.

[6] Higher order lags in the prefecture GDP series are not statistically significant.

Including these variables does not change the estimate significantly, while both of these control variables turn out to be insignificant.[7] In columns (4) and (5) we further control for private investment and employment in order to capture supply-side effects from the capital and labor markets. Even after including these additional control variables, the elasticity estimate continues to be around 0.04 and is statistically significant at the 1 percent level.

Table 1. Government Investment Elasticities

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Government Investment	0.051***	0.050***	0.049***	0.037***	0.036***	0.030**	0.033***
	(0.011)	(0.011)	(0.012)	(0.013)	(0.013)	(0.013)	(0.013)
Lagged GDP	0.732***	0.722***	0.725***	0.629***	0.627***	0.581***	0.588***
	(0.039)	(0.041)	(0.054)	(0.050)	(0.051)	(0.040)	(0.040)
Tax Revenue		-0.022	-0.022	-0.019	-0.019	-0.138***	-0.130***
		(0.032)	(0.032)	(0.030)	(0.029)	(0.023)	(0.025)
Public Debt			0.003	-0.001	0.001	-0.003	0.004
			(0.022)	(0.021)	(0.020)	(0.013)	(0.015)
Private Investment				0.097***	0.100***	0.068***	0.064***
				(0.026)	(0.026)	(0.023)	(0.021)
Employment					0.039	-0.003	0.015
					(0.070)	(0.061)	(0.059)
Exports						0.038*	0.043**
						(0.020)	(0.021)
Public Investment Externality							0.006
							(0.040)
AR(2) Test, p-value	0.558	0.514	0.515	0.663	0.648	0.276	0.262
Hansen J, p-value	0.782	0.772	0.818	0.895	0.898	0.905	0.996
Prefecture FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	470	470	470	470	470	410	410

Source: Fund staff estimates.
Note: The method of estimation is SYS-GMM using instruments dating 2 years and further back (Blundell and Bond, 1998). Heteroscedasticity and autocorrelation robust standard errors are shown in parentheses. The dependent variable is log GDP; all explanatory variables are in logs. To obtain the dY/dG multiplier effect the estimates need to be multiplied by the inverse of G/Y which is (1/0.12). *Significantly different from zero at the 90 percent confidence level, ** 95 percent confidence level, *** 99 percent confidence level.

To account for intra-regional trade effects, we include prefecture exports as an additional regressor in the estimating equation (column 6). Increases in exports have a significant positive effect on output but controlling for exports does not significantly change our estimate of the elasticity of government investment spending. It could, however, be that our panel estimates miss out on important spillover effects of government investment undertaken by other prefectures. To check this, we construct a government investment externality series computed as the sum of all government investment undertaken by other prefectures. This

[7] The insignificance of the debt variable is consistent with the theoretical literature on the neutrality of debt (see for instance, Barro, 1989).

investment externality series enters with a coefficient of 0.006 (column (7)), suggesting that government investment undertaken in other prefectures has positive spillover effects. However, this coefficient is not statistically significant and quantitatively very small. Nonetheless, to the extent that the spillover effects of government spending are not fully captured, our estimates of the regional elasticity are likely to be a lower bound for the country-wide average elasticity effect.

B. Government Investment Multiplier Estimates

Transforming the dynamic panel estimates obtained above by multiplying the elasticity estimate with the inverse of the average public investment to GDP ratio, we get an impact multiplier effect of public investment on regional output of 0.28.[8] The medium-term multiplier effect of government investment on output depends on the persistence of the government spending shock. For a fully persistent shock, the cumulative effect on output is 0.67.[9]

An interesting policy question has been whether investments in public infrastructure projects—a key focus of numerous fiscal stimulus packages—yield higher multiplier effects than other investments. To address this question, we repeat the above analysis, distinguishing between government investment by purpose ("livelihood", industry, agriculture, land conservation, and other investment).[10] Contrary to expectations, we find that the estimate for "industry," which covers investments in highways harbors and other infrastructure, comprising nearly a quarter of the public investment spending, is among the lowest (Table 2). We also find that the estimate for "livelihood" investment, which comprises nearly half of the public investment, is higher than that for "industry." Such investments are primarily investments in tertiary roads, educational facilities, and public sewerage implemented by city, town, and village level governments. The multiplier estimate is the highest for investments in "agriculture", though this comprises a small share of total investment.

[8] Multiplier (0.28) = Elasticity (.033)/Public Investment to GDP ratio (0.12).

[9] Medium-term multiplier (0.67) = Multiplier (0.28) / (1- coefficient on the lagged dependent variable (0.588)).

[10] "Livelihood" investments generally refer to city level government investments such as in school and hospital buildings, water supplies and sanitation; "industry" investments refer to harbors, national highways, airports, etc. See Appendix II for details on the coverage of the different types of investment.

Table 2. Estimates of the Government Investment Multiplier by Type of Investment and Administrative Level

	(1)	(2)	(3)	(4)
	By Type		By Administrative Level	
	Elasticity	Multiplier	Elasticity	Multiplier
Livelihood	0.018*	0.35		
	(0.011)			
Industry	0.003	0.15		
	(0.005)			
Agriculture	0.029**	2.04		
	(0.012)			
Land Conservation	0.011	1.15		
	(0.010)			
Other	0.005	0.41		
	(0.004)			
Central Government			0.008	0.26
			(0.008)	
Prefecture Government			0.003	0.14
			(0.012)	
City Government			0.033***	0.78
			(0.012)	
Prefecture FE	Yes		Yes	
Year FE	Yes		Yes	
Observations	410		410	

Note: The method of estimation is SYS-GMM using instruments dating 2 years and further back (Blundell and Bond, 1998). Heteroscedasticity and autocorrelation robust standard errors are shown in parentheses. The dependent variable is log GDP; all explanatory variables are in logs. Additional control variables (not shown) are tax revenue, public debt, private investment, exports, and lagged GDP. To obtain the dY/dG multiplier on investment expenditures by type of investment the estimates on livelihood investment need to be multiplied by 1/(0.053); industry investment by 1/(0.026); agriculture investment 1/(0.015); land conservation investment by1/(0.012); and other investment by 1/(0.012). To obtain the dY/dG multiplier on investment expenditures by administrative level the estimates on central government investment need to be multiplied by 1/(0.040); prefecture government investment by 1/(0.036); and city government investment by 1/(0.045). *Significantly different from zero at the 90 percent confidence level, ** 95 percent confidence level, *** 99 percent confidence level.

We further examine the multiplier effects of investment spending by administrative level (central government, prefecture government, city government). Consistent with the findings above, we find that government investment undertaken by the cities had multipliers that were much higher than the investment multiplier on projects carried out by the central government and the prefectures (Table 2, column 4). The estimates suggest that decentralized government investment is more effective than centralized government investment. This could possibly reflect shorter lags in project implementation as spending is focused on maintenance of existing projects and better targeting of projects. Moreover, the fact that local governments had greater financial constraints, particularly as the local (property) tax revenues declined sharply, meant that transfers from the central government could be more quickly spent.

C. The Government Expenditure Multiplier

We repeat the empirical analysis for public expenditure by the local (prefecture-level) government. Local government spending comprises a significant share of total public

spending. For example, in 1990, public expenditure from the ordinary accounts of the local government constituted 65 percent of the net expenditure of the general account of the national government and the ordinary account of the local government.

Table 3, column (1) presents the estimates of the elasticity and associated multiplier for aggregate government expenditure without distinguishing by type of government spending. The control variables (not shown) beyond the prefecture and year fixed effects are lagged GDP, tax revenues, public debt, private investment, employment, and exports. The average multiplier on local government expenditures is positive and significant. Quantitatively the multiplier effect is rather small as the elasticity estimate of 0.036 implies an impact multiplier on local government expenditures of about 0.26 and a cumulative multiplier of about 0.53. These estimates tend to be on the lower end of the VAR estimates in the literature, which range from 0.4 to 2.0, although they represent different time horizons.[11]

Table 3. Estimates of the Local Government Expenditure Multiplier

	(1)	(2)	(3)	(4)	(5)
	All Local Gov. Expenditures	Transfers to Firms	Ordinary Construction	Social Assistance	Government Personnel
Elasticity estimate	0.036* (0.02)	0.045** (0.02)	0.036*** (0.01)	-0.001 (0.01)	-0.011 (0.07)
Implied multiplier	0.26	3.46	0.76	-0.25	-0.28
AR(2) Test, p-value	0.219	0.169	0.409	0.354	0.358
Hansen J, p-value	0.983	0.996	0.997	0.985	0.991
Prefecture FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	410	410	410	410	410

Note: The method of estimation is SYS-GMM using instruments dating 2 years and further back (Blundell and Bond, 1998). Heteroscedasticity and autocorrelation robust standard errors are shown in parentheses. The dependent variable is GDP; all variables are in logs. Additional control variables (not shown) are tax revenue, public debt, private investment, exports, and lagged GDP. To obtain the dY/dG multipliers the estimates in column (1) need to be multiplied by 1/(0.138); column (2) by 1/(0.013); column (3) by 1/(0.047); column (4) by 1/(0.004); and column (5) by 1/(0.039). *Significantly different from zero at the 90 percent confidence level, ** 95 percent confidence level, *** 99 percent confidence level.

Next, we examine the multiplier effects of local government expenditures by distinguishing between the different components of government spending. The dataset provides a breakdown of government expenditure in key areas such as ordinary construction, social assistance (subsidy to households), transfers to firms, and government personnel. We find that there are substantial differences in these elasticity estimates and the multipliers (Table 3,

[11] Aside from the methodological differences, the estimation time period is likely a key reason for the difference with estimates from other studies in the literature. As we show later, the multiplier estimate is larger for earlier time periods.

columns (2)–(5)). Government expenditure on investment such as "ordinary construction" has a positive and statistically significant multiplier effect while that of subsidy expenditures—which represent social assistance to low income households—turns out to be negative and insignificant. Furthermore, we find that government expenditure on personnel has a negative and insignificant effect on GDP.[12]

D. Robustness Analysis

To examine the robustness of these results, we also estimate the multipliers using alternative methodologies (see Appendix III).

- First, we estimate the model using a panel VAR methodology with one lag. The multiplier for the public investment is close to the baseline estimate at 0.24. For local government expenditure multiplier, the estimate is slightly higher at 0.49 (Appendix Table 11).

- Second, we re-estimate equation (1) using level differences rather than a log-log specification. This methodology allows us to obtain the multiplier directly instead of deriving it indirectly from the elasticity estimate and the average share of public spending. We find that the multiplier estimate for public investment is higher (0.67), with a 95 percent confidence interval band of 0.3 to 1.04 (Appendix Table 12). For local government spending, the estimate is also higher at 0.58 with a 95 percent confidence interval band of .12 and .99.

- Third, we re-estimate the elasticity equation (Table 1, column 7) with a quadratic term under the baseline log specification to control for potential non-linearities. The coefficient on the quadratic term is positive and significant for both the regressions on public investment and on local government expenditure, suggesting that the estimate of the elasticity at different levels of public spending could vary. At the sample average, the multipliers for the public investment and the local government expenditure were estimated to be 0.26 and 0.21, respectively. We also explored potential non-linearities in the effect of public investment on output by interacting public investment with private investment and private consumption. This did not significantly change the average marginal effect of public investment on output, and produced quantitatively small interaction effects that were only marginally significant.

- To test whether the elasticity estimates are larger when the output gap is negative, we also interacted the elasticity equation with the sample output gap estimates. The

[12] For an empirical study of OECD countries that finds similar adverse effects of government personnel expenditure, see for example, Alesina and others (2002). On the other hand, Pappa (2009) documents that for the United States, private employment increases significantly due to increases in government expenditure.

interaction term is negative, consistent with the expectations that when supply constraints are binding because of a large positive output gap, the multiplier impact will be lower. However, this effect is not statistically significant.

Table 4. Estimates of the Public Investment Multipliers in the Literature

Publication	Country	Multiplier	Methodology	Type of estimate	Description
Hida, et.al. (2008)	Japan	1.1	Error Correction Model	Multiplier	Maximum
Perotti (2004)	Australia	1.07	VAR - quarterly	Multiplier	Maximum, Cumulative
	Canada	0.74			
	Germany	5.46			
	United Kingdom	0.16			
	Untied States	1.68			
Afonso and Aubyn (2008)	France	1.5	VAR - annual	Multiplier	Cumulative
	Germany	1.7		(Marginal	
	Canada	-2.3		Productivity)	
	United Kingdom	-1.6			
	Japan	.014			
	United States	1.8			
Freedman, Kumhof,	United States	1.8	Dynamic Neo-Keynesian	Multiplier	Period 1
Laxton and Lee (2009)	Euro	1.4	Model		
	Japan	1.6			
	Emerging Asia	1.1			
	Rest of G-20	1.9			
Zandi (2008)	United States	1.6	n.a.	Multiplier	Infrastructure
Miyazaki (2007)	Japan	.008 and -.012	VAR - monthly	Elasticity, for central and local govt	Industrial Production, construction
Mittnik and Neumann (2001)	Canada	0.08	VECM- quarterly	Elasticity	Period 1
	France	0.055			
	United Kindgom	0.005			
	Japan	0.1			
	Netherlands	0.14			
	Germany	0.1			

Source: Various studies cited above.

How do these estimates compare with the literature? While the estimates of public investment multipliers estimated for various countries vary significantly in the literature (Table 4), our baseline estimate of 0.28 for the short-term multiplier and 0.56 for the long-term multiplier (based on an elasticity of 0.033) for public investment tends to be on the lower end of the range of these estimates. This is particularly the case when compared with theoretical dynamic general equilibrium models. Caution is needed in comparing the size of the multipliers, however, given the differences in time horizons over which the multiplier is estimated and the differences in the methodologies adopted.

V. Factors Contributing to the Low Multipliers

To gain an understanding for why the estimated multipliers were relatively small—though statistically significant—we examine some possible reasons for low multiplier effects as pointed out in the literature. One of the main criticisms of the fiscal stimulus programs in

Japan has been the inefficient allocation of public investment projects. We focus on the allocation of public investment across regions to see if equity objectives led to tradeoffs with efficiency. We exploit the heterogeneity inherent in the regional data to examine the relationship between regional investment, multipliers, and marginal productivity.

Another criticism leveled at public investment policy in Japan has been that overinvestment and the high capital stock has led to low marginal productivity. It is argued in the literature that if public investment increases marginal productivity of private factor inputs, it can crowd in private investment and output over the long run. The effect of this channel can contribute to offset the crowding out of private investment through higher financing costs. Similarly, this supply side channel can reduce the negative wealth effects on private consumption in the short run if households believe that it will lead to higher output (and reduced tax burden) in future. We therefore assess the marginal productivity of public capital and complement this analysis with the traditional demand-side analysis of crowding out effects.

A. Testing for Crowding Out Effects

We begin by examining the effects of public expenditure on private investment and private consumption (Table 5). Panel A presents estimates for the effects of government investment, while Panel B presents the corresponding estimates for local government expenditure. All regressions control for prefecture and year fixed effects, prefecture-year changes in tax revenues, public debt, exports, employment, and output as well as private investment where appropriate.

We find that public investment had a positive but statistically insignificant effect on private investment with a coefficient of 0.22 (Table 5, column 1, Panel A). In column (2), we show that there were crowding out effects of government investment on private consumption. Specifically, we find that a 1 percent increase in government investment decreased private consumption by 0.1 percent. The theoretical macro literature predicts an increase in private investment in response to increases in ‘productive’ public investment expenditure. Negative wealth effects lead households to lower consumption and also substitute higher labor supply. Higher labor input would raise the marginal product of capital and thus induce higher capital accumulation (Baxter and King, 1993). The empirical evidence here shows that while there is evidence of crowding out of private consumption, the complementary effect on private investment is rather weak, suggesting that the marginal productivity of private investment is likely expected to be low.

Table 5. The Effect of Government Investment (Expenditures) on Private Investment and Consumption

	Panel A: Total Government Investment	
	(1)	(2)
	Private Investment	Private Consumption
Total Government	0.219	-0.099*
Investment	(0.144)	(0.06)
Prefecture FE	Yes	Yes
Year FE	Yes	Yes
Observations	371	410
	Panel B: Local Government Expenditures	
	(1)	(2)
	Private Investment	Private Consumption
Local Government	-0.518***	0.063
Expenditures	(0.195)	(0.192)
Prefecture FE	Yes	Yes
Year FE	Yes	Yes
Observations	371	410

Note: The method of estimation is SYS-GMM using instruments dating 2 years and further back (Blundell and Bond, 1998). Heteroscedasticity and autocorrelation robust standard errors are shown in parentheses. Additional control variables (not shown) are tax revenue, debt, exports, employment, and GDP as well as private investment where appropriate. The dependent variable in column (1) is private investment; column (2) private consumption. All variables are in logs. *Significantly different from zero at the 90 percent confidence level, ** 95 percent confidence level, *** 99 percent confidence level.

With respect to local government expenditure, we find that it had stronger crowding out effects on private investment (column 1, panel B): a 10 percent increase in government expenditures decreased private investment by more than 5.2 percent on average and the effect is statistically significant. On the other hand, local government expenditures are found to have a positive but statistically insignificant effect on private consumption.[13]

In the case of Japan, the literature on crowding out through consumption also remains divided, with some studies finding that the marginal propensity to consume not very sensitive to public debt due to the low level of net debt at the time (Bhattacharya, 1999). Furthermore, the literature on the impact of fiscal variables on interest rates in Japan is also inconclusive. Nakazato and others (2003) do not find a significant positive relationship between fiscal variables and long-term nominal interest rate. Kameda (2008), however, finds a positive

[13] The empirical macro literature on crowding out effects remains divided with some papers finding a negative effect of government spending on private investment (Blanchard and Perotti, 2002; or Mountford and Uhlig, 2008) as well as a negative effect on private consumption (Edelberg and others, 1999) while others have found private consumption and private investment to weakly increase in response to positive government expenditure shocks (Fatas and Mihov, 2001; Burnside and others, 2004; Gali and others, 2007).

association between debt/deficit and interest rates using forecast data of the fiscal variables.[14] Other studies have argued that multipliers were small and even negative as fiscal expansion was offset by higher precautionary private savings as it faced an aging population. However, data during the nineties suggest that savings rate was already declining as savings were being drawn down by the large elderly population.

B. Regional Allocation of Government Investment: Efficiency vs. Equity

The debate on the effectiveness of the fiscal stimuli packages undertaken in Japan during the nineties has also focused on the role of political forces. In particular, the allocation of government investment based on regional equity motives rather than efficiency motives may be another reason why the multiplier was quantitatively small. To explore this question, we re-estimate elasticity equation, allowing the coefficient *p* to vary across prefectures. Econometrically, we obtain elasticity estimates for the 47 different prefectures by interacting the government investment series with the prefecture fixed effect.[15] Figure 4 presents the kernel density estimate of the 47 point estimates of the multiplier, evaluated at the average investment to GDP for each prefecture, which show substantial dispersion.

To check how the allocation of public investment is correlated with efficiency, we compare average public investment per capita at the prefecture level during the nineties and the prefecture-specific investment multiplier. We compute a nonparametric local polynomial estimate of average investment per capita regressed on the investment multiplier. The results from this kernel regression show an upward-sloping relationship between public investment per capita and the multiplier (Figure 5), suggesting that more investment went to those regions where the multiplier was higher.

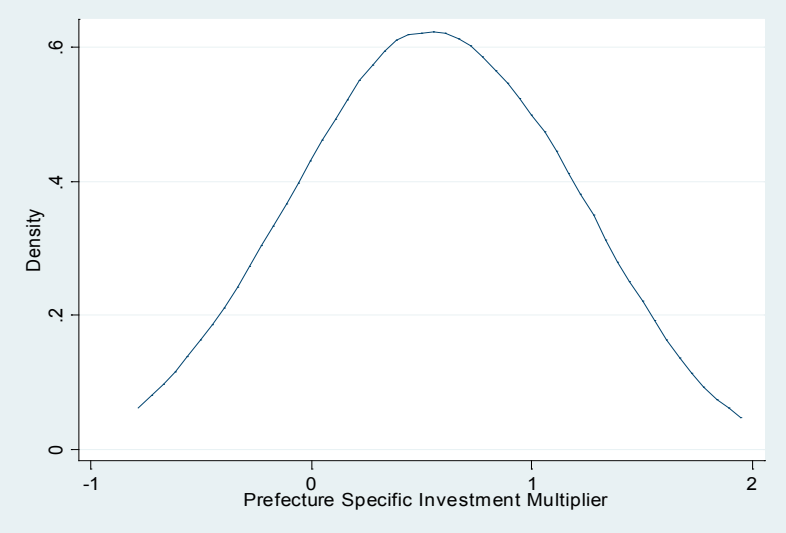
In Figure 6 we repeat the exercise plotting on the x-axis the prefecture-specific per capita GDP level. The non-parametrically estimated relationship is downward sloping, indicating an equity motive in the allocation of government investment, as would be expected. The allocation also does not appear to be geared towards relieving population bottlenecks. In the absence of forward and backward linkages, which create opportunities for economies of scale, investing in less densely populated and poorer regions can compromise output gains. However, the tradeoffs with multiplier effects here seem limited. This suggests that a misallocation to regions with lower multipliers does not seem to be a large factor in explaining the low aggregate multiplier level.

---

[14] We tested the effect of rising local government debt on coupon rates and find a positive, statistically significant effect which is suggestive of crowding out effects. However, data limitations on the prices of the bonds suggest caution in interpreting these results.

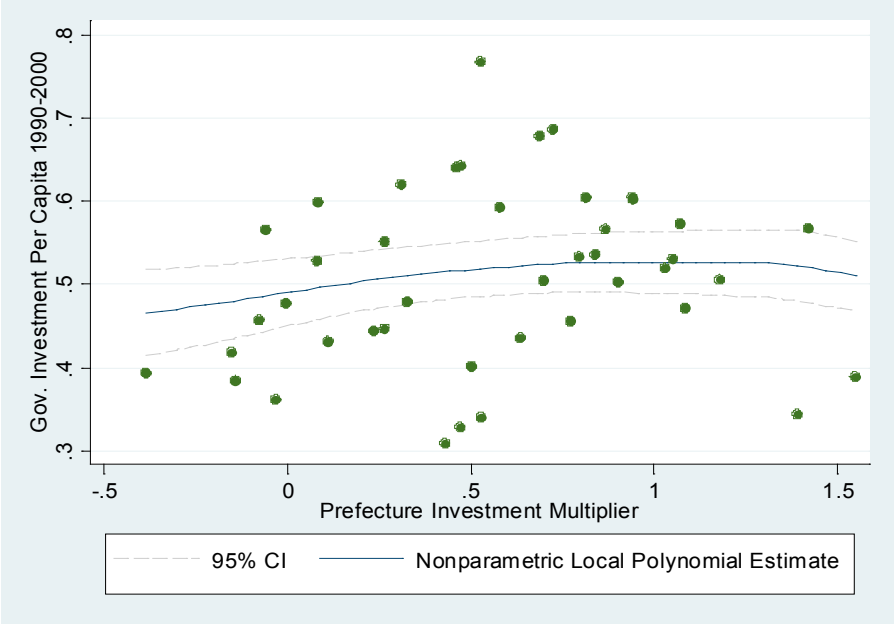
[15] Control variables continue to be prefecture fixed effects and year fixed effects, as well as tax revenue, debt, private investment, employment, exports, and lagged GDP.

Figure 4. Heterogeneity in Government Investment Multipliers Across Prefectures



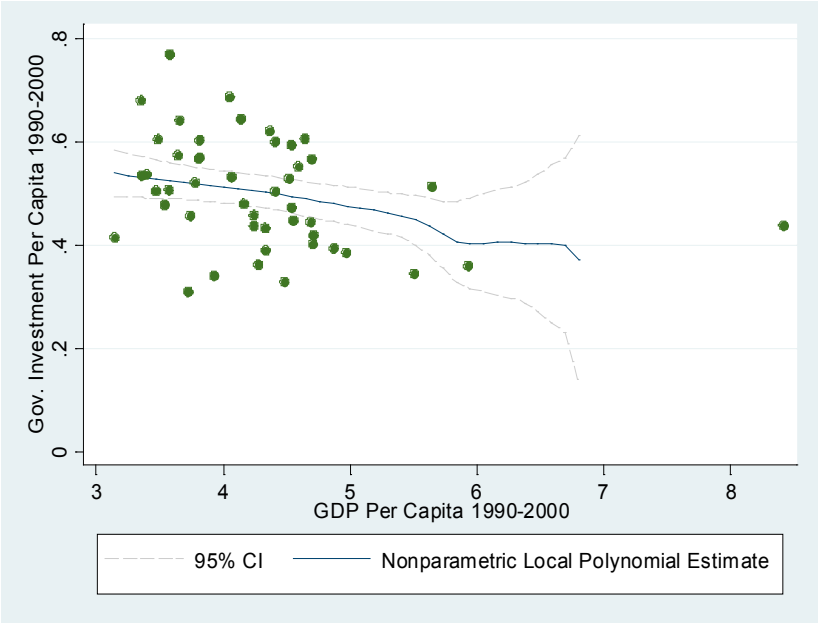
Note: The nonparametric density estimate is computed using an Epanechnikov kernel. The prefecture-specific investment multipliers are obtained from a panel regression where coefficients on the investment multiplier are allowed to vary across prefectures.

Figure 5. Heterogeneity in the Government Investment Multiplier and Total Government Investment



Note: The nonparametric local polynomial estimate is computed using an Epanechnikov kernel. Prefecture-specific investment multipliers are obtained from a panel regression where coefficients on the investment multiplier are allowed to vary across prefectures. Dashed lines indicate 95 percent confidence bands.

Figure 6. Government Investment and Prefecture Differences in Per Capita GDP



Note: The nonparametric local polynomial estimate is computed using an Epanechnikov kernel. Prefecture-specific investment multipliers are obtained from a panel regression where coefficients on the investment multiplier are allowed to vary across prefectures. Dashed lines indicate 95 percent confidence bands.

C. Declining Marginal Productivity of Public Capital

Another strand of literature approaches the issue from the supply side. As discussed earlier, an increase in public investment that is "productive" and raises future income could help offset the negative wealth effects on private consumption, thereby strengthening the short-run impact of an increase in public investment on output. According to this line of thought, the low multiplier effect is explained by the low marginal productivity of capital. Several studies have documented that the marginal product of capital has been on the decline over the years in Japan due to overinvestment in the economy.[16] To examine this conjecture, we compute the elasticity of capital across prefectures by estimating the production function for regional output. Following Aschauer (1979) and Munnell (1990), we assume that public capital is productive and enters the production function, which allows us to assess the productivity of public capital. Assuming a generalized Cobb Douglas production function and translating the equation in logarithms in the spirit of Blundell and Bond (2000), we consider the following equation:

[16] Japan's public investment ratio, in the early nineties, was nearly double that of other advanced industrial countries and the capital stock was among the highest in the OECD (Kamps, 2004). Hayashi and Prescott (2002) document the decline in total factor productivity in Japan during the 1990s that led to a decline in the rate of return from capital. The paper also notes that under the assumption that TFP growth remains low, capital deepening would not increase growth in output per worker as the capital stock is near its steady state value.

$$y_{it} = \beta_k k_{it} + \beta_l l_{it} + \beta_g g_{it} + \gamma_t + \eta_i + \upsilon_{it}$$
$$\upsilon_{it} = \alpha \upsilon_{i,t-1} + e_{it} \qquad |\alpha| < 1,\ e_{it} \sim MA(0)$$

where the elasticity of private and public capital are denoted by β_k and β_g, respectively. An important constraint is the calculation of the capital stock for the prefectures. For this estimation, we obtained the data on the public and private capital stock from Doi (1998) covering the period 1975–98.

In Table 6 we report our estimates of the elasticity of both private and public capital. Column (1) imposes constant returns to scale in all three factors of production and this yields estimates of the private and public capital elasticity of 0.28 and 0.32, respectively. In column (2), we relax the constant returns to scale assumption and this yields somewhat larger point estimates of the capital elasticity of 0.58 for private capital and 0.46 for public capital.

Figure 7 documents the decline of the marginal product of public capital for the 1975–2000 period. We construct the marginal product of public capital in a given year as the estimated elasticity of public capital (as estimated in Table 4, column (1)) times the output to public capital ratio, which shows a declining marginal product of capital. The decline was particularly strong for the 1975–85 and 1990–2000 periods. This points towards a substantial decline in the productivity of public investment in the 1990s.

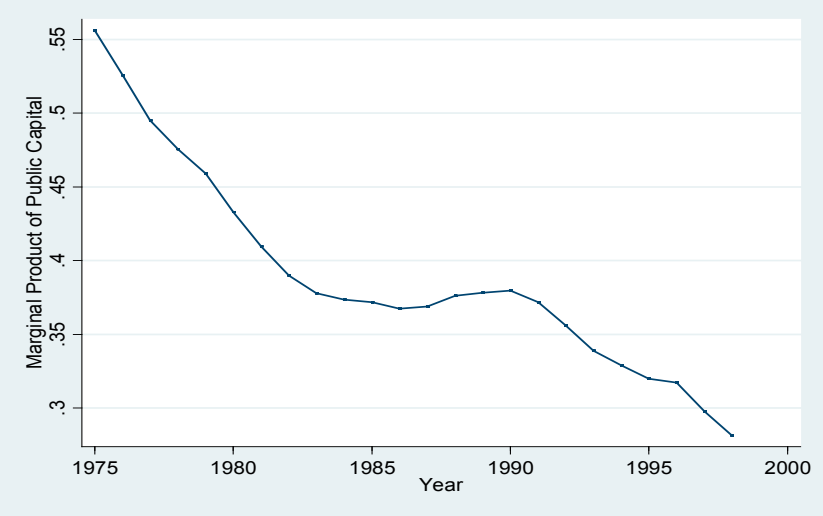
In Table 7 we show that indeed the fiscal multiplier was larger during the pre-1990 period than for the 1990–2000 period. The estimates in column (1) of Table 7 show that a 1 percent increase in government expenditures increased output in Japan during the 70s and 80s by about 0.10 percent. Since the average share of government expenditures in GDP for this time period is about 0.12, the estimated elasticity parameter implies an expenditure multiplier of about 0.8. For the 1990–2000 period, on the other hand, the estimated elasticity implies an expenditure multiplier of about 0.6. Hence, the government expenditure multiplier was about 20 to 25 percent larger for the 1975–1989 period relative to the 1990–2000 period. The decline in the multiplier over time is consistent with the decline in the marginal product of public capital as shown in Figure 7. Moreover, the decline in the multiplier over time for Japan matches the findings of Perotti (2005) who documents a decline in the government expenditure multiplier also for other OECD countries.

Table 6. Estimates of the Output Elasticity of Public Capital

	(1)	(2)
	Imposing Constant Returns to Scale	Flexible Functional Form
Private Capital Elasticity	0.283** (0.13)	0.580*** (0.18)
Public Capital Elasticity	0.323*** (0.10)	0.461*** (0.13)
Prefecture FE	Yes	Yes
Year FE	Yes	Yes
Observations	368	368

Note: The method of estimation is SYS-GMM using instruments dating 2 years and further back (Blundell and Bond, 1998). Heteroscedasticity and autocorrelation robust standard errors are shown in parentheses. The dependent variable is GDP. All variables are in logs. *Significantly different from zero at the 90 percent confidence level, ** 95 percent confidence level, *** 99 percent confidence level.

Figure 7. Declining Marginal Product of Capital



Source: Fund staff estimates.

Table 7. Evolution of the Government Expenditure Multiplier Over Time

	1975–1989	1990–2000
	(1)	(2)
Government Expenditures	0.102*** (0.03)	0.087*** (0.02)
Implied Multiplier	0.8	0.6
Prefecture FE	Yes	Yes
Year FE	Yes	Yes
Observations	690	470

Note: The method of estimation is SYS-GMM using instruments dating 2 years and further back (Blundell and Bond, 1998). Heteroscedasticity and autocorrelation robust standard errors are shown in parentheses. The dependent variable is GDP. All variables are in logs. Control variables are the lagged GDP in addition to the fixed effects. To obtain the dY/dG multiplier effect the estimates need to be multiplied by the inverse of G/Y which is (0.12)-1 for the 1975-1989 period and (0.14)-1 for the 1990–2000 period. *Significantly different from zero at the 90 percent confidence level, ** 95 percent confidence level, *** 99 percent confidence level.

D. Other Factors

In addition to the above factors, the literature discusses several other factors that could have contributed to the low multiplier effects. Baxter and King (1993) discuss the role of the duration of shocks. Permanent changes in government expenditure have larger effects than transitory changes in government expenditure. Considering the uncertainties in the budget process and the duration of the stimulus spending, the transitory nature of the expenditure packages may also explain the low multiplier. The economy's response to an increase in government expenditure also depends on how the increase is financed (Ludvigson, 1996). Distortionary tax financing may lead to a decline in output, consumption, and investment. In contrast, deficit financing may increase output and consumption. This reason would be hard to reconcile in the Japanese context, given the large increase in deficits and cuts in income taxes over this period. More recent studies have also focused on the role of the zero lower bound (Christiano, Eichenbaum, and Rebelo, 2009). The multiplier should be largest when monetary policy has hit the lower zero bound. In this context, it is notable that at the beginning of the 1990s the nominal interest rate was at about 8 percent, reaching the zero bound only towards the end of the decade.

VI. Conclusion

How effective was public investment in stimulating the economy in Japan during the economic stagnation of the 1990s? The similarities of the current crisis and the policy responses by national governments make this an interesting question. We revisit this issue and seek to assess the size of the multiplier effects of public investment using a rich dataset of regional investment spending. We find investment multipliers are low and have declined over time. Nonetheless, they are higher than the multipliers for public consumption. Interestingly, the public investment multipliers for the local governments are higher than that of the central governments. Similarly, the multiplier for economic infrastructure investment, typically undertaken by the central government, are higher than for social investment that are implemented by local governments.

In trying to understand the cause of the low multipliers, we find some evidence for crowding-out effects. Aggregate supply side factors, namely, overinvestment and the relatively large preexisting public capital stock, have also diminished the marginal productivity of capital over time, which is manifest in the declining multipliers. Variations in investment multipliers by region suggest the interregional distribution of investment—inspired by equity objectives—did not come at the expense of efficiency. Nevertheless, there are substantial differences in multipliers by type of investment spending, and the level of government implementing these projects also has a bearing on effectiveness of this investment. Going forward, these considerations should be borne in mind when utilizing public investment to stimulate economic activity.

Appendix I: Fiscal Stimulus Packages in Japan since 1990s

Appendix Table 8. Fiscal Stimulus Packages from 1990 to 2008

	1 1992 Aug Stimulus Package	2 1993 Apr Stimulus Package	3 1993 Sep Stimulus Package	4 1994 Feb Stimulus Package	1995 Tax Reform	5 1995 Apr Stimulus Package	6 1995 Sep Stimulus Package	1996 Tax Reform	1997 Tax Reform	7 1998 Apr Stimulus Package	8 1998 Nov Stimulus Package	9 1999 Nov Stimulus Package	10 2000 Oct Stimulus Package	11 2001 Oct Stimulus Package	12 2001 Dec Stimulus Package	13 2002 Dec Stimulus Package	14 2008 Aug Stimulus Package	15 2008 Oct Stimulus Package	TOTAL
Tax cut		**0.2**		**5.9**	**2.0**			**2.0**	**2.0**	**4.6**	**6.0**								**22.6**
Ad hoc personal income tax cut				5.5	2.0			2.0	2.0	4.0									**15.5**
Permanent tax cut in personal and corporate income tax											6.0	Note 3)							**6.0**
Other tax cuts included in the stimulus package		0.2		0.4						0.6									**1.1**
Cash transfer to households											**0.7**							**2.0**	**2.7**
Government investments (Ig) to build up social infrastructure	**6.3**	**7.2**	**2.0**	**3.7**		**5.4**	**9.1**			**7.7**	**8.1**	**6.8**	**5.2**		**4.2**	**3.4**	**1.9**	**2.2**	**73.1**
Public works involving central government	4.5	5.6	1.5	3.4			6.7			1.6	3.6	2.9	2.6		2.3	2.6		1.0	**38.2**
Public works by local governments	1.8	1.6	0.5	0.3			1.0			1.5									**6.7**
Science and technology						0.3				1	1.1	1.2	1		1.2	0.3	0.2	0.1	**6.4**
Education and social welfare										1	1.1	0.6	0.5		0.7	0.5		0.7	**5.1**
Alternative energy and environment										1.6	1	0.6	0.6						**3.8**
Natural disaster relief						5.1	1.4			1	1.3	1.6	0.5				1.7	0.4	**13.0**
Other government measures for;	**4.5**	**5.8**	**4.0**	**5.7**		**1.5**	**5.2**			**4.4**	**9.1**	**11.3**	**5.8**	**5.8**	**0.0**	**11.8**	**9.6**	**22.7**	**107.1**
Acquisition of land for public use	1.6	1.6	0.3	2.3			3.2			1.1									**10.1**
Employment support		0.0		0.0			0.0			0.1	1.0	1.0	1.3	1.3		0.9		0.3	**5.9**
Expansion of policy lending for housing sector	0.8	1.8	2.9	1.2			0.5				1.2	2							**10.4**
Expansion of policy lending and government guarantees for non-financial sector (small and medium size businesses)	1.2	1.9	0.8	1.4		1.4	1.4			2.0	5.9	7.4	4.5	4.5		10.9	9.1	21.8	**74.2**
Others	0.9	0.5		0.8		0.1				1.2	1	0.9					0.5	0.6	**6.5**
Total size of stimulus package	**10.8**	**13.2**	**5.9**	**15.2**	**2.0**	**7.0**	**14.2**	**2.0**	**2.0**	**16.7**	**23.9**	**18.1**	**11.0**	**5.8**	**4.2**	**15.2**	**11.5**	**26.9**	**205.5**
Total size/ GDP (%)	2.2	2.7	1.2	3.1		1.4	2.9			3.3	4.7	3.6	2.2	1.2	0.9	3.1	2.2	5.1	**2.3 (avarage)**
of which (Ig + Tax cuts + Cash transfer)	**6.3**	**7.4**	**2.0**	**9.6**	**2.0**	**5.4**	**9.1**	**2.0**	**2.0**	**12.3**	**14.8**	**6.8**	**5.2**	**0.0**	**4.2**	**3.4**	**1.9**	**4.2**	**98.4**
(Ig+Tax cuts+Cash transfer) / GDP (%)	1.3	1.5	0.4	2.0	0.4	1.1	1.8	0.4	0.4	2.4	2.9	1.4	1.0	0.0	0.9	0.7	0.4	0.8	**1.1 (avarage)**
Nominal GDP	483.8	480.7	480.7	487.0	496.5	496.5	496.5	508.4	513.3	503.3	503.3	499.5	504.1	493.6	493.6	489.9	526.9	526.9	
Central government bond issuance in supplementary budgets	2.3	2.2	3.6	2.2		2.8	4.7			6.1	12.3	7.6	2.0	1.7	0.0	5.0	0.4	n.a.	**52.9**

Source: Nakagawa (2009).
1/ There was an economic package in June 1999 to boost employment by 700 thousand jobs by deregulations and so on, involving almost no additional budgetary outlays. Therefore, this package is not listed in the table.
2/ Nominal GDP for 2008 is an estimation by the Japanese government.
3/ Tax cuts announced in the 1998 November stimulus package was implemented from FY1999 and lifted in FY2007.

Appendix II. Data Description

We obtain annual prefecture level data for 47 Japanese prefectures during the 1990–2000 period from the Japan Statistical Yearbook. The Japan Statistical Yearbook provides detailed data at the prefecture level on government investment that is obtained from the annual report on administrative investment from the Ministry of Home Affairs. The investment data are expenditure based and cover expenditures on the maintenance and repair of facilities, improvement projects (including cost of land and compensation), office expenses, and planning and surveys. The Japan Statistical Yearbook also provides detailed local government finance data on government expenditures and government tax revenues from the ordinary accounts of local governments. The data are from the annual statistical report on local government finance of the Ministry of Home Affairs and are based on the reports submitted by the local public bodies. We also obtain from the Japan Statistical Yearbook prefecture-level GDP, export, employment, and investment data. In Appendix Table 9 we provide a matrix of the within-prefecture correlation of the data and in Appendix Table 10 we provide a detailed description of the specific investment measures used in our empirical analysis.

Appendix Table 9. Correlation Matrix

	GDP	Gov. Investment	Gov. Tax Revenue	Government Debt	Exports	Private Investment	Employment
GDP	1						
Gov. Investment	0.4098	1					
Gov. Tax Revenue	0.6444	0.4314	1				
Government Debt	-0.0835	-0.0390	-0.0888	1			
Exports	0.2873	0.1349	0.2470	0.0028	1		
Private Investment	0.3282	0.3450	0.3860	-0.0096	0.1245	1	
Employment	0.0942	-0.1191	0.0016	0.0127	-0.0317	-0.0726	1

Source: Authors' calculations.

Appendix Table 10. Description of Specific Investment Measures Used

Variable	Description	Source
Livelihood Investment (44 % of total investment)	• city, town and village roads • streets • city planning • housing • environment sanitation • welfare (including works of hospitals) • educational facilities • water supplies	Japan Statistical Yearbook
Industry Investment (22 % of total investment)	• national highways and prefectural roads • harbors • airports • industrial water	Japan Statistical Yearbook
Agricultural Investment (12 % of total investment)	• agriculture, forestry, fishery	Japan Statistical Yearbook
Land Conservation Investment (10 % of total investment)	• forest and river conservation • seashore conservation	Japan Statistical Yearbook
Other Investment (12 % of total investment)	• unemployment measures • disaster restoration • government office repairs • railways • subways electricity • gas • residential land formation • other	Japan Statistical Yearbook

Source: Japan Statistical Yearbook.

Appendix III. Alternative Estimation Strategies:

In this Appendix we present estimates of the investment and local government expenditure multiplier for the 1990-2000 period based on two alternative estimation strategies: panel VAR estimation and dynamic panel first-difference level estimation.

Panel VAR estimation

For the panel VAR regressions we return to the log-log specification that is common in the empirical business cycle literature. We include in our panel VAR model six variables: GDP, government expenditures, tax revenues, private investment, employment, and exports. Formally, our one-lag panel VAR model can be written as:

$$Z_{c,t} = \Theta Z_{c,t-1} + a_c + d_t + v_{c,t}$$

where, Z = (GDP, government expenditures, tax revenues, private investment, employment, exports). We estimate the model by Generalized Methods of Moments, using the programs written by Love and Ziccino (2006). Appendix Table 11 provides the estimates for the government spending multipliers obtained from the panel VAR regressions. As can be seen, the panel VAR estimates are similar to the estimates obtained from the dynamic panel regressions. Moreover, the panel VAR estimates confirm that on average the government expenditure multiplier during the 1990s was not significantly larger than 1.

Appendix Table 11. Panel VAR Estimates of the Government Spending Multiplier

	Elasticity Estimate	G/Y	dY/dG Multiplier Estimate	95% Confidence Interval
Total Investment Expenditures	0.030	0.121	0.25	[-0.07; 0.57]
Local Government Expenditures	0.067	0.138	0.49	[0.18; 0.80]

Source: Authors' calculations.

Dynamic panel first-difference level estimation

The econometric model for the first-difference level estimation can be written as follows:

$$\Delta Y_{c,t} = \varphi \Delta Y_{c,t-1} + d_t + p^* \Delta G_{c,t} + D^T \Delta X_{c,t} + \Delta e_{c,t}\,.$$

The notation is exactly the same as in Section III, but all variables are specified in levels rather than logs. Hence, for the first-difference level specification the dY/dG multiplier is given by the estimated coefficient p. Contrary to the log-log specification, no adjustment is therefore needed to obtain the dY/dG multiplier. Note that we specified the above equation in

first-differences because the levels of the series indicated unit-root dynamics, which was not the case in the log-log specification.

Appendix Table 12. Dynamic Panel First-Difference Level Estimates of the Government Spending Multiplier

	Estimated dY/dG Multiplier	95% Confidence Interval
Total Investment Expenditures	0.66	[0.29; 1.04]
Local Government Expenditures	0.58	[0.12; 0.99]

Source: Authors' calculations.

References

Afonso, A., and M. Aubyn, 2008, "Macroeconomic Rates of Return of Public and Private Investment: Crowing-In and Crowding-Out Effects," ECB Working Paper No. 864.

Alesina, A., S. Ardagna, R. Perotti, and F. Schiantarelli, 2002, "Fiscal Policy, Profits, and Investment," *American Economic Review,* Vol. 92, pp. 571–89.

Barro, R., 1989, "The Ricardian Approach to Budget Deficits," *Journal of Economic Perspectives,* Vol. 3, pp. 37–54.

Baxter, M., and R. King, 1993, "Fiscal Policy in General Equilibrium," *American Economic Review,* Vol. 83, pp. 315–35.

Bayoumi, T., 2000, "The Morning After: Explaining the Slowdown in Japanese Growth," in *Post Bubble Blues: How Japan Responded to Asset Price Collapse*, ed. by T. Bayoumi and C. Collyns (Washington: International Monetary Fund).

Bhattacharta, R., 1999, "Private Sector Behavior and Non-Keynesian Effects of Fiscal Policy," IMF Working Paper 99/112 (Washington: International Monetary Fund).

Blanchard, O., and R. Perotti, 2002, "An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output," *Quarterly Journal of Economihow wascs,* Vol.117, pp. 1329–68.

Blundell, R., and S. Bond, 1998, "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models," *Journal of Econometrics,* Vol. 87, pp. 115–43.

———, 2000, "GMM Estimation with Persistent Panel Data: An Application to Production Functions," *Econometric Reviews,* Vol. 19, pp. 321–40.

Burnside, C., M. Eichenbaum, and J. Fisher, 2004, "Fiscal Shocks and their Consequences," *Journal of Economic Theory,* Vol. 115, pp. 89-117.

Christiano, L., M. Eichenbaum, and S. Rebelo, 2009, "When is the Government Spending Multiplier Large?" NBER Working Paper 15395.

Doi, T., 1998, "Policies, Business Cycles, and Elections in Japan," *Journal of Economic Studies,* Vol. 40, pp. 29–45.

Edelberg, W., M. Eichenbaum, and J. Fisher, 1999, "Understanding the Effects of a Shock to Government Purchases," *Review of Economics Dynamics,* Vol. 2, pp. 166–206.

Fatas, A., and I. Mihov, 2001, "The Effects of Fiscal Policy on Employment and Consumption: Theory and Evidence," CEPR Discussion Paper No. 2760.

Freedman, C., M. Kumhof, D. Laxton, and J. Lee, 2009, "The Case for Global Fiscal Stimulus," IMF Staff Position Note 09/03 (Washington: International Monetary Fund).

Gali, J., J. Lopez-Salido, and J. Valles, 2007, "Understanding the Effects of Government Spending on Consumption," *Journal of the European Economic Association,* Vol. 5, pp. 227–70.

Hayashi, F., and E. Prescott, 2002, "The 1990s in Japan: A Lost Decade," *Review of Economic Dynamics,* Vol. 5, pp. 206–35.

Hemming, R., M. Kell, and S. Mahfouz, 2002, "The Effectiveness of Fiscal Policy in Stimulating Economic Activity—A Review of the Literature," IMF Working Paper 02/208 (Washington: International Monetary Fund).

Hida, F., K. Iwamoto, H. Shigihara, K. Tanaka, and H. Umei, 2008, "The ESRI Short-Run Macroeconometric Model of the Japanese Economy (2008 version)—Basic Structure, Multipliers, and Economic Policy Analyses," ESRI Discussion Paper Series No. 201.

Ihori, T., T. Nakazato, and M. Kawade, 2003, *Japan's Fiscal Policies in the 1990s* (Oxford: Blackwell Publishing Ltd.)

International Monetary Fund, 2009, "Revisiting Japan's Lost Decade," Regional Economic Outlook: Asia and Pacific (May; Washington: International Monetary Fund).

Kalra, S., 2003, "Fiscal Policy: An Evaluation of its Effectiveness," in *Japan's Lost Decade: Policies for Economic Revival*, ed. by Tim Callen and Jonathon Ostry (Washington: International Monetary Fund).

Kameda, K., 2008, "Budget Deficits, Government Debt and Interest Rates in Japan: An Analysis Using Published Budgetary Forecasts," mimeo (Kwansei Gakuin University).

Kamps, C., 2004, "New Estimates of Government Capital Stocks for 22 OECD Countries 1960–2001," IMF Working Paper 04/67 (Washington: International Monetary Fund).

Kondoh, H., 2008, "Political Economy of Public Capital Formation in Japan," *Public Policy Review,* Vol. 4, pp. 77–110.

Kuttner, K., and A. Posen, 2002, "Fiscal Policy Effectiveness in Japan," *Journal of the Japanese and International Economics,* Vol. 16, pp. 536–58.

Love, I., and L. Ziccino, 2006, "Financial Development and Dynamic Investment Behaviour: Evidence from Panel VAR," *Quarterly Review of Economics and Finance,* Vol. 46 pp. 190–210.

Ludvigson, S., 1996, "The Macroeconomic Effects of Government Debt in a Stochastic Growth Model," *Journal of Monetary Economics,* Vol. 38, pp. 24–45.

Matsuoka, M., 1996, "Measuring the Effects of Fiscal Policy in Japan" (unpublished; Daiwa Institute).

Mittnik, S., and T. Neumann, 2001, "Dynamic Effects from Public Investment: Vector Autoregressive Evidence from Six Industrialized Countries," *Empirical Economics,* Vol. 26, pp. 429–46.

Miyazaki, T., 2009, "Public Investment and Business Cycles: The Case of Japan," *Journal of Asian Economics,* Vol. 20, pp. 419–26.

Mountford, A., and H. Uhlig, 2008, "What are the Effects of Fiscal Policy Shocks," NBER Working Papers No. 14551.

Munnell, A., 1990, "How Does Public Infrastructure Affect Regional Economic Performance?" *New England Economic Review,* pp. 11–32 (September/October; Federal Reserve Bank of Boston).

Murata, K., and T. Saito, 2004, "The ESRI Short-Run Macroeconometric Model of Japanese Economy (2004 version)—Basic Structure, Multipliers, and Economic Policy Analyses," ESRI Discussion Paper No. 122.

Nakagawa, M., 2009, "Note on Stimulus Packages in Japan Since 1990s," (unpublished; International Monetary Fund).

Nakazato, T., Y. Soejima, Y. Shabata, and M. Kasuya, 2003, "Fiscal Sustainability and the Long-Term Interest Rates," Bank of Japan Working Paper Series No. 03-J-7.

Organization for Economic Cooperation and Development, 2000, *Japan—OECD Economic Surveys*, 1999–2000 (Paris: Organization for Economic Cooperation and Development Publishing).

Pappa, E., 2009, "The Effects of Fiscal Shocks on Employment and the Real Wage," *International Economic Review,* Vol. 50, pp. 217–44.

Perotti, R., 2004, "Public Investment: Another (Different) Look," IGIER Working Papers No. 277 (Milan: Bocconi University Innocenzo Gasparini Institute for Economic Research).

Posen, Adam, 2004, "What Went Right in Japan," Policy Briefs in International Economics, Institute for International Economics, PB4-6.

Yamano, T., and N. Ohkawara, 2000, "The Regional Allocation of Public Investment: Efficiency or Equity?" *Journal of Regional Science,* Vol. 40, pp. 205–29.

Yoshino, N., and E. Sakakibara, 2002, "The Current State of the Japanese Economy and Remedies," *Asian Economic Papers,* Vol. 1, pp. 110–26.

Zandi, M., 2008, "A Second Quick Boost From Government Could Spark Recovery," edited excerpts from July 24, 2008, testimony by Mark Zandi, chief economist of Moody's Economy.com, before the U.S. House of Representatives Committee on Small Business.