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Measuring Government Intervention and Estimating its Effect on Output: With Reference to the High Performing Asian Economies

by

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Abstract
Previous empirical work on the effect of government intervention on economic performance has used government spending as a proxy for intervention. This proxy is imperfect as many East Asian economies have low levels of government spending but high levels of government intervention. This paper uses different proxies for government intervention and includes them in a neoclassical growth model to examine the effect of intervention on output per worker, using cross-country data. High levels of government ownership are found to be negatively correlated with the level of output per worker, and weak evidence is found of a negative correlation between high levels of price controls and output per worker. Once government consumption is measured in local prices there is no evidence of any significant correlation between government consumption and output per worker.

Outline

I INTRODUCTION

When looking for a proxy for the degree of government intervention to use in empirical work on economic growth, economists have typically made use of data on government spending. The existing empirical work is far from reaching a consensus on the effects of government spending, with some studies finding a negative correlation between government spending and economic performance, others finding a positive correlation and others finding no significant correlation at all. This paper will argue that several of the studies which find a negative correlation do so only because they measure government consumption in a misleading manner. More importantly, it will also be argued that government spending is a poor proxy for government intervention more generally, and that finding a correlation of any sign between government spending and economic performance should not be taken to imply that other forms of government intervention have the same effect.

For evidence that government spending is an imperfect proxy for government intervention more generally, we need look no further than the High Performing Asian Economies (HPAEs).[1] Over the years economists have debated the extent to which governments have intervened in these economies. However, in recent times, it has become accepted by most that all but Hong Kong have intervened more than industrialised country governments.[2] These countries, however, also have very low levels of government spending and taxation. If we were to use government spending as our sole proxy for government intervention we would be led to conclude that these countries have had the most laissez-faire approach to economic management in the world - a conclusion that many would feel uncomfortable with. It is, therefore, necessary to come up with additional proxies to measure the degree of intervention to include in empirical work on the effect of government intervention on economic performance. This paper will suggest two such proxies and include them in a neoclassical growth model, for which empirical estimates will be obtained.

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1 The World Bank (1993) coined the term "High Performing Asian Economies" to describe Japan, Hong Kong, Singapore, Taiwan, South Korea, Malaysia, Thailand and Indonesia. These have been the fastest growing Asian economies, with the exception of China.

2 For arguments as to why the view may have persisted for so long that government intervention was minimal in these countries see Garces and Knowles (2000).

The remainder of the paper will be organised as follows. Section Two will review the existing empirical literature on government intervention and economic performance, to bring out the reliance in this literature on government spending as a proxy for intervention. Section Three will then discuss in more detail why government spending is a poor proxy for government intervention, with reference to the East Asian economies. Section Four will discuss two additional measures of government intervention. In Section Five it will be shown how government intervention can be incorporated into the neoclassical growth model, and this model will be empirically tested in Section Six. Section Seven will conclude.

II A REVIEW OF THE EMPIRICAL LITERATURE ON INTERVENTION AND ECONOMIC PERFORMANCE

Several empirical studies have attempted to quantify the effect of government intervention on economic growth, with the majority of these studies using government spending as a proxy for intervention.[3] Some of these studies focus only on government consumption.[4] Most of the studies use either cross-country or panel data, although a small number do use time-series data. The discussion which follows will survey a representative sample of the existing literature. A more extensive summary can be found in the appendix to Kneller, Bleaney and Gemmell (1998).

Studies relying solely on government consumption as a proxy for the size of government include Ram (1986) and Alexander (1994) (which find a positive correlation between government consumption and growth), Alexander (1990) (which finds a negative correlation) and Kormendi and Meguire (1985) and Evans (1997) (which find no significant correlation). The two Alexander papers use panel data for a sample of OECD countries, Evans uses time-series data for 92 countries, whereas the other studies use cross-country data.

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3 Some of the research that looks at the effect of government spending on growth only claims to be looking at the effect of fiscal policy on growth (eg Kneller, Bleaney and Gemmell 1999). However, others explicitly claim that they are looking at the effects of government intervention. For example, Thomas and Wang (1996) claim in their introduction that they are going to look at the effect of government interventions and distortions on growth.

4 Government consumption is equal to government spending minus government investment and transfer payments.

There are other studies which go beyond those just discussed in two ways. The first is to disaggregate government spending into different components, the second is to include taxation in the analysis. As argued by Kneller, Bleaney and Gemmell (1999), to exclude taxation means ignoring the potential distortions caused by financing government spending. Easterly and Rebelo (1993) include a variety of different measures of government spending and taxation in Barro-style regressions, using cross-country data, and find that only government investment in transport and communications is (positively) correlated with growth. Kocherlakota and Yi (1996) examine the effect of marginal taxes and measures of government investment in structural capital on long-run GNP levels. The only significant variables are investments in non-military capital equipment and non-military structural capital, both of which are positively correlated with GNP.

Kneller, Bleaney and Gemmell (1999) examine the effect of both government expenditure and taxation on economic growth using panel data for 22 OECD countries. They disaggregate expenditure into 'productive' expenditure (expenditure with a substantial physical or human capital component) and 'unproductive' expenditure (the main item of which is social security spending).[5] Productive expenditure is significant and positively correlated with growth (although it is insignificant when estimated using instrumental variables), whereas non-productive expenditures are insignificant. Distortionary taxation, defined as taxation which affects investment decisions, is significant and negatively correlated with growth. Similar results are obtained by Bleaney, Gemmell and Kneller (2000), when lagged values of the fiscal variables are included to allow fiscal policy to have a long-run effect on growth. Folster and Henrekson (1998) examine the effect of government expenditure and taxation (but don't include both in the same estimating equation) on economic growth using panel data for a group of high-income countries and find both variables to be significantly negatively correlated with growth. Their measure of government expenditure includes government consumption, government investment and transfer payments.

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5 Productive expenditures are defined as spending on general public services, defence, education, health, housing and transport and communication. Non-productive expenditure is defined as social security and welfare, recreation and economic services.

Several studies by Robert Barro (e.g. Barro 1991; Barro and Lee 1994a; Barro and Sala-i-Martin 1995) proxy for intervention using government consumption, net of spending on education and defence. Barro (1991, p.430) argues that 'expenditures on education and defense are more like public investment than public consumption; in particular, these expenditures are likely to affect private sector productivity or property rights, which matter for private investment.' It is a common finding in Barro's work that there is a negative partial correlation between government consumption and economic growth across countries. Barro (1991) also includes public investment as a proportion of GDP as an explanatory variable, but finds it to be insignificant.

Barro's work also includes proxies for price distortions within the economy, and, therefore, goes a step further than the studies that rely only on government spending and taxation as measures of intervention. However, it will be argued that the proxies Barro uses contain a limited amount of information. Barro (1991) proxies for price distortions by calculating the absolute value of the deviation of the investment deflator from the sample mean in 1960 arguing that 'either artificially high investment prices or artificially low investment prices proxy for distortions.' (p.433). This variable simply measures whether the prices of capital goods are in line with other countries in the world. It is not clear that this necessarily proxies for price distortions. Barro and Lee (1994a) include the black market premium on foreign exchange as a measure of price distortions. The black market premium measures the difference between the official exchange rate and the price of foreign exchange on the black market. Therefore, it is a reliable measure of price distortions, but only for one price – foreign exchange. Barro and Lee find that higher distortions are significantly correlated with lower rates of economic growth.

One study that casts the net slightly wider in the search for suitable proxies for intervention is Thomas and Wang (1996). Thomas and Wang calculate two indices: INDEX1 which attempts to measure openness and macroeconomic stability, and INDEX2 which measures government expenditures. INDEX1 is made up of seven separate measures: a trade policy index, inflation, real interest rates, the parallel market premium (a measure of the black market premium on foreign exchange), an index for outward-orientation, an index for trade liberalisation and an index for agricultural protectionism. Given the variables included in INDEX1 it can be best interpreted as a measure of trade openness and financial market stability. Although the black market

premium is a possible proxy for price distortions, it only measures distortions in exchange rates.

INDEX2 is made up of five different measures of government spending. These are the shares in GDP of public-sector investment, total government expenditure, fixed capital formation, subsidies, and productive expenditures (expenditures on education and health, plus economic and infrastructural spending). The various components of each index are converted into index form using the Borda technique which provides an ordinal ranking of countries, rather than a cardinal measure.

Thomas and Wang use cross-country data for 68 countries (10 East Asian countries plus 58 other developing countries) to estimate the effect of INDEX1 and INDEX2 on economic growth and total factor productivity growth. INDEX 1 has a significantly positive effect on economic growth and total factor productivity growth. INDEX 2 is significantly correlated with economic growth and total factor productivity growth, but in a non-linear manner.[6] Although Thomas and Wang introduce more proxies for intervention than other studies, their indices are dominated by measures of government spending and openness to trade. Given that the East Asian economies are largely open and have low levels of government spending, this masks the fact that some of the East Asian economies have intervened heavily in economic activity. The fact that several measures are included in each INDEX also makes it impossible to isolate the separate effect of each component.[7]

What conclusions can we draw from the existing empirical work? Studies that look at the effect of government consumption on growth can find a positive, negative or insignificant correlation between this variable and growth. Barro's work suggests that the correlation is negative if spending on education and defence (which he considers to be investment

6 The empirical results suggest that INDEX2 is positively correlated with GDP growth and productivity growth up to a point. However, beyond this point the relationship becomes negative. In other words, there is an inverted-U shaped relationship between government spending and both GDP and productivity growth.

7 Thomas and Wang's argument for using indices is as follows. Given that intervention is multidimensional it seems desirable to focus on as many measures of intervention as possible. However, for many indicators there are missing country observations, making the estimation of multivariate regressions problematic. They see the Borda technique as a solution to this problem as it can still be calculated when the data are missing for some observations.

rather than consumption spending) are netted out of government consumption. Other studies find that some forms of government spending are positively correlated with growth. Some studies show that the black market premium on foreign exchange is negatively correlated with growth, but this measures price distortions on foreign exchange only, which may not be representative of price distortions in the economy in general. The existing literature relies heavily on various measures of government spending and taxation as proxies for intervention. However, there is very little work focusing on the effect of other types of intervention on economic growth. The next section will discuss the fact that low levels of government spending do not necessarily imply a lack of other forms of intervention.

III WHY GOVERNMENT SPENDING IS NOT A GOOD PROXY FOR INTERVENTION: THE CASE OF THE HIGH PERFORMING ASIAN ECONOMIES

One of the main arguments of this paper is that government spending is a poor proxy for government intervention more generally, as in many economies around the world government intervention is high, even though government spending is low. The aim of this section of the paper is to discuss this point more fully, with reference to the East Asian economies.

There was a time when the East Asian economies were held up by some as paragons of the free market (eg Chen 1979; Friedman and Friedman 1980). However, case studies of various East Asian economies (e.g. Amsden 1989 on South Korea; Wade 1990 on Taiwan; Bello and Rosenfeld 1992 on South Korea, Taiwan and Singapore; Amsden (1991) on East Asia more generally) have catalogued significant government interventions in these economies. This is despite the fact that most East Asian economies have low levels of government spending relative to the industrialised economies (see Table One).[8]

Governments in some East Asian countries have issued explicit instructions to business regarding what to produce and, in some instances, how to produce it. For example, the

8 In Table One we present data on the Philippines, a country that has experienced high growth rates in recent years, as well as for the eight HPAEs. Data for China are unavailable.

Park regime in South Korea instructed the Chaebol to export labour-intensive manufactured exports in the 1960s and early 1970s, and more capital-intensive goods during the Heavy and Chemical Industries (HCI) drive which began in 1973 and reached a climax in 1977-9.

Park employed various techniques to ensure that his directives were followed. When Park assumed power in 1961 he had members of the business elite arrested for alleged corruption under the previous regime and threatened to confiscate their assets. He then exempted them from prosecution on the understanding that they followed his economic directives (Amsden 1989, p.72). Businesses that failed to meet export targets set by Park were liable to face the wrath of tax auditors (Bello and Rosenfeld 1992, p.54; Song 1994, p.96)[9] or to have their supply from utilities, such as electricity, cut (Bello and Rosenfeld 1992, p.54). Access to credit was also on the basis of successful export performance.

Another way that governments can attempt to influence the allocation of resources is through influencing relative prices. This can either be achieved by setting prices (in many countries this takes the form of setting maximum or minimum prices) or by the use of subsidies or indirect taxes. In Singapore wages were set by the National Wages Council in the 1970s and 1980s (Fields and Wan 1989, p.1475). The provision of capital at subsidised rates has also been common in East Asia (Tan 1995, p.43). An example of subsidies in the goods market is the subsidisation of rice and fuel in Indonesia. Data on the extent of price controls in East Asia are presented in Table One. The data show that the only East Asian country with little or no price controls is Hong Kong; with price controls being the most pervasive in the Philippines, South Korea and Thailand.

Government ownership of key industries is not uncommon in the region. The government of Taiwan established a network of state owned enterprises in selected key industries in an effort to promote rapid economic growth (Wade 1990; Macintyre 1994). Tan (1995, p.44) argues that '[i]n all of the Asian NICs (except Hong Kong), the government intervened by participating directly in business through the ownership of banks, hotels and manufacturing firms.' Some 500 companies are fully or partly owned by the government

9 Song (1994: 96) argues that dual accounting used to be common in South Korea, making firms particularly vulnerable to taxation audits. It was not uncommon for firms to become bankrupt following such audits.

in Singapore (Fields and Wan 1989, p.1475). Data on the extent of government ownership over the period 1975-84, presented in Table One, show state ownership to have been the greatest in Indonesia, followed by the Philippines, Taiwan and Malaysia. Government ownership has been negligible in Hong Kong.

Governments can also regulate economic activity in a variety of ways. In the labour market laws can be introduced limiting the power of unions, or banning union activity altogether. Regulation of the labour market has been common in the past in Singapore and South Korea. In South Korea it was illegal to strike between 1972 and 1981 (Fields and Wan 1989, p.1478). In goods markets, governments can require firms to have licenses to sell goods (a common example of this form of intervention is import licensing).

This section has shown that government intervention in East Asia has been extensive, despite the fact that government spending is low in these countries. This suggests that government spending is not a good proxy for government intervention more generally. The existing empirical work, surveyed in Section Two, may provide insights on the effect of government spending (and, in some cases, taxation) on economic growth, but should not be interpreted as saying anything about the effects of other forms of government intervention.

IV ADDITIONAL MEASURES OF GOVERNMENT INTERVENTION

The discussion above indicated several ways that governments can intervene in economic activity: government spending (and taxation to pay for this spending), directing firms what to produce, influencing relative prices (either through regulation, taxes or subsidies), regulation of factor and goods markets (eg licensing, limits on union activity) and government ownership of industry.

As discussed in Section Two, empirical work on the effect of government intervention on economic performance has tended to use government spending as a proxy for intervention. However, as we have seen in Section Three, there are many other ways that governments have intervened in East Asia. The reason for focusing on government spending, especially government consumption, has probably been that the data are readily available, and are measured with reasonable accuracy.

Other aspects of government intervention are more difficult to quantify, as there is not always an obvious unit of measurement for forms of intervention such as regulation of the labour market. One publication which attempts to provide measures of the extent of government intervention is *Economic Freedom of the World*, which is published annually. Careful analysis of the data in the 1996 edition (Gwartney, Lawson and Block, 1996) revealed that data are available which attempt to capture the degree of government ownership of industry (GOE) and the extent of price controls (PRICE).[10] These data are summarised in Table One, along with data on the more traditional government spending measures.

Table One: Measuring government intervention in East Asia

Country	G/Y(net) 1975-84	G/Y (Barro) 1975-84	GOE 1975-85	PRICE 1989
Japan	4.9	3.5	8	6
Hong Kong	4.2	2.9	10	10
Singapore	2.5	0.6	8	8
Taiwan	6.1	12.0	4	6
South Korea	2.3	1.3	6	3
Malaysia	5.5	4.0	4.7	5
Thailand	4.9	7.9	6	4
Indonesia	5.3	7.6	2.7	6
Philippines	4.6	11.5	4	2
East Asia	4.5	5.7	5.9	5.6
UK	10.9	7.2	4.7	8
USA	8.4	0.8	8	8
Industrial - Japan	10.9	5.5	4.9	6.4
LDCs - EA	8.0	12.1	4.1	2.6

G/Y(net) is government consumption net of spending on education and defence, with all ratios measured in local currencies. The data have been calculated from the Barro and Lee (1994b data set). Barro G/Y is government consumption net of spending on education and defence, with government consumption measured in international prices (however spending on education and defence is measured in local currencies). The data are from Barro and Lee (1994b). GOE indicates the extent of government operated enterprises in the economy. A rating of 10 indicates a low degree of government ownership, a 0 indicates that the economy is dominated by government operated industries. PRICE indicates the extent to which price controls are imposed on various goods and services. 10 indicates no use of price controls, 0 indicates extensive use of price controls. The GOE and PRICE data are from Gwartney et al (1996). The data for East Asia are the average for the 9 East Asian countries included in the table. The industrial countries are the 19 countries (excluding Japan) classed as industrial by Gwartney, Lawson and Block (1996).

10 Data on other forms of intervention, reported in Gwartney, Lawson and Block were also considered, but were not included in our analysis for various reasons. For example, it was discovered that the data on financial market regulation, for most countries, simply reflected whether real interest rates were positive or negative, which doesn't necessarily reflect the extent of government intervention.

The first column in the table reports data on government consumption net of spending on education and defence (G/Y(net)), which are measured in local currencies.[11] These data have been calculated from the Barro and Lee (1994b data set). The data show that all the East Asian economies have lower levels of government consumption than the industrialised country average. It is often suggested that South Korea is one of the more interventionist governments, but this does not show up in the data on G/Y.

The next column gives data on G/Y(Barro). These data are measured in international, rather than local, prices. The data are from Barro and Lee (1994b) and are constructed from the Penn World Tables, produced by Summers and Heston (1988, 1991). Such data have been used widely in empirical work (eg Barro and Lee 1994a; Barro and Sala-i-Martin 1995). The Barro and Lee data on government consumption net of education and defence spending suggest that such spending is very low in the United States. This may be because the data do not include spending at the local government and state level. Government consumption is almost zero in Singapore and South Korea.[12] The average figure for the East Asian economies for this measure is almost identical to that for the industrialised countries.

As has been argued by Knowles (2000), it is not necessarily appropriate to measure ratios such as G/Y, or for that matter I/Y, in international prices as this can seriously distort the data. In developing countries the price of labour, relative to capital, is low, and the government sector tends to be labour intensive. Therefore, G/Y is likely to be low when measured in local prices. If G/Y is measured in international prices, as is the case in the Penn World Tables data set, this is likely to increase G/Y for low-income countries. This is because, in the Penn World Tables, relative prices in each and every country are set equal to the weighted average of relative prices for the world as a whole. This increases the relative price of labour for low-income countries, increasing the price of goods

11 It is not valid to compare variables such as output per worker across countries using local currencies, as this is not comparing like with like. However, it is valid to compare G/Y across countries in local prices as the measurement error in the numerator and denominator cancels out.

12 The notes accompanying the Barro and Lee data set note that "[s]ince total government consumption and defence/education expenditures are differently measured, net government consumption ratios are negative for some countries. For these cases we assumed 0.01" (Barro and Lee, 1994b).

produced in the labour-intensive government sector, relative to the non-government sector, artificially increasing G/Y. Hence, conversion to international prices tends to increase G/Y for low-income countries and decrease it for high-income countries. The opposite occurs for I/Y. With respect to G/Y, this pattern is readily observable in Table One. For the higher-income countries the G/Y(Barro) data are lower than G/Y(net) and for the lower-income countries (such as Indonesia and the Philippines) the G/Y(Barro) data are higher than G/Y(net).

It seems strange to calculate G/Y in a country like the Philippines or Indonesia using the relative prices that prevail in other countries, but this is exactly what conversion to international prices, as in the Penn World Tables data set, achieves. The fact that government's share in output would increase if an alternative set of relative prices were used seems irrelevant. The case for using international prices seems even weaker if we consider what effect this would have on measuring the average tax rate, which assuming a balanced budget is equal to G/Y. To use international prices would imply that statutory tax rates are much higher in developing countries, and lower in high-income countries, than they actually are. Given that the residents of a country pay their taxes in local currencies, it does not seem sensible to measure the average tax rate using another set of relative prices.

Of the studies surveyed in Section Two, Ram (1986), Barro (1991), Barro and Lee (1994a) and Barro and Sala-i-Martin (1995) measure G/Y in international prices, with the other studies all using data based on local prices. Recall that Ram (1986) found a significant positive coefficient on government consumption, the Barro studies all obtained a negative coefficient.

The price control variable (PRICE) appears to more accurately reflect a priori expectations about the degree of intervention in the region. This variable is measured as an index and indicates the extent to which price controls are imposed on various goods and services. 10 indicates no use of price controls, 0 indicates extensive use of price controls. More details on this variable are given in the appendix. All of the East Asian countries except Hong Kong and Singapore are shown to be more interventionist than the

industrialised-country average, and Hong Kong is the only East Asian economy with fewer price controls than the UK or USA.

GOE indicates the extent of government operated enterprises in the economy. A rating of 10 indicates a low degree of government ownership, a 0 indicates that the economy is dominated by government operated industries. More detail on the GOE variable is given in the appendix.[13] Government ownership is more prevalent in some of the East Asian countries than in the industrialised countries.

This paper has argued that government spending, whether measured in local or international prices, is an imperfect proxy for government intervention. This is because many East Asian governments have intervened extensively in economic activity, but these countries have low levels of government spending. Alternative proxies for intervention include the extent of price controls and the degree of government ownership in the economy. The remainder of this paper will be concerned with modelling and empirically testing the effect of these alternative forms of government intervention on economic performance by including these variables in a neoclassical growth model framework. For the sake of comparison with the existing literature, government spending will also be included in the model.[14]

V MODELLING THE EFFECT OF GOVERNMENT INTERVENTION ON OUTPUT PER WORKER AND ECONOMIC GROWTH

Our model extends that of Mankiw, Romer and Weil (1992) (hereafter MRW) by allowing government consumption, price controls and the extent of government

13 An alternative to using this index would be to measure the proportion of the labour force employed by the government, or the share of output produced by government owned industries. The use of the index takes both of these factors into account, as well as taking account of what sectors of the economy are dominated by the government.

14 It could be argued that taxation should also be included in the model. However, the central argument of this paper is that government spending and taxation are imperfect proxies for government intervention. Government consumption is included simply for the sake of comparison with existing work, all of which includes some measure of government spending, but the majority of which excludes taxation. Taxation and government spending are also likely to be highly correlated, unless taxation is disaggregated into distortionary and non-distortionary, as suggested by Kneller, Bleaney and Gemmell (1999) and Bleaney, Gemmell and Kneller (2000). For the broad cross-section of countries included in this paper, this would prove problematic.

ownership to affect the level of total factor productivity. The aggregate production function is given by

(1) $$Y_t = K_t^{\alpha} H_t^{\beta} (A_t L_t)^{1-\alpha-\beta}$$

where Y is the level of real output, K the level of physical capital, H the level of human capital, L the labour force and A the level of efficiency. The subscript t denotes time period t. The production function exhibits constant returns to scale and diminishing returns to each factor. Equation (1) can be rewritten in terms of units per effective worker (eg $y = Y/AL$) as follows

(2) $$y_t = k_t^{\alpha} h_t^{\beta}$$

Following MRW the labour force is assumed to grow exponentially as follows

(3) $$L_t = L_0 e^{nt}$$

where n is the exogenously determined growth rate of the labour force.

MRW assume that A evolves according to the formula

(4) $$A_t = A_0 e^{gt}$$

where g reflects the growth rate of technology and A_0 reflects the level of efficiency, or total factor productivity, in the base period. As well as reflecting base-period technology, which in the context of the neoclassical growth model is constant across countries, they argue that it will also capture other variables which will vary across countries, such as "resource endowments, climate, institutions, and so on" (p.411). More formally, $\ln(A_0) = a + \varepsilon$, where a is constant across countries and ε is a country-specific error term.

Knight, Loayza and Villanueva (1993) show that variables, other than technology, which are expected to affect the level of efficiency within the economy can be included in

equation (4). A similar approach is suggested by Aron (1997). Our government intervention variables can be incorporated in the model by rewriting equation (4) as

$$A_t = A_0 e^{gt} C^{\theta_c} P^{\theta_p} E^{\theta_e} \tag{5}$$

where C is government consumption, P the extent of price controls and E the degree of government ownership in the economy. θ_c, θ_p and θ_e are elasticities which represent the effect of government consumption, price controls and government ownership on the level of efficiency within the economy.

Equations for the evolution of physical and human capital are given in equations (6) and (7) respectively

$$\dot{k}_t = s_k y_t - (n + g + \delta)k_t \tag{6}$$

$$\dot{h}_t = s_h y_t - (n + g + \delta)h_t \tag{7}$$

where s_k and s_h are the fractions of output invested in physical and human capital respectively and δ is the rate of depreciation, which is assumed to be the same for each factor, and is assumed to be common across countries. Given the assumption of diminishing marginal products for each factor of production, physical and human capital per worker will tend towards the steady states given by equations (8) and (9)

$$k^* = \left(\frac{s_k^{1-\beta} s_h^{\beta}}{n + g + \delta} \right)^{1/(1-\alpha-\beta)} \tag{8}$$

$$h^* = \left(\frac{s_k^{\alpha} s_h^{1-\alpha}}{n + g + \delta} \right)^{1/(1-\alpha-\beta)} \tag{9}$$

where an asterisk (*) denotes the steady-state value of a variable. Substituting equations (5), (8) and (9) into (2), taking natural logarithms and rearranging gives

$$(10)\qquad \ln\left(\frac{Y}{L}\right)^{*} = \ln A_0 + gt + \frac{\alpha}{1-\alpha-\beta}\ln(s_k) + \frac{\beta}{1-\alpha-\beta}\ln(s_h) - \frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g+\delta)$$

$$+\theta_c \ln C + \theta_p \ln P + \theta_e \ln E$$

Subsuming $\ln A_0$ into a constant (a) and error term (ε) gives the following equation for estimation

$$(11)\qquad \ln\left(\frac{Y}{L}\right)^{*} = a + \frac{\alpha}{1-\alpha-\beta}\ln(s_k) + \frac{\beta}{1-\alpha-\beta}\ln(s_h) - \frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g+\delta)$$

$$+\theta_c \ln C + \theta_p \ln P + \theta_e \ln E + \varepsilon_t$$

Note that there is a restriction implicit in equation (11) that the coefficients on $\ln(s_k)$, $\ln(s_h)$ and $\ln(n+g+\delta)$ sum to zero.

Equation (11) explains the level of output per worker, when the economy is in the steady-state. A Taylor series approximation around the steady state gives the following equation for the growth rate of output per worker during the transition to the steady state

$$(12)\qquad \ln\left(\frac{Y_t}{L_t}\right) - \ln\left(\frac{Y_0}{L_0}\right) = a + \frac{\gamma\alpha}{1-\alpha-\beta}\ln(s_k) + \frac{\gamma\beta}{1-\alpha-\beta}\ln(s_h) - \frac{\gamma(\alpha+\beta)}{1-\alpha-\beta}\ln(n+g+\delta)$$

$$+\gamma\theta_c \ln C + \gamma\theta_p \ln P + \gamma\theta_e \ln E - \gamma \ln\left(\frac{Y_0}{L_0}\right) + \varepsilon_t$$

where $\gamma = (1-e^{-\lambda t})$ and λ represents the speed of convergence to the steady state.

It is possible to obtain estimates for the parameters of the production function by estimating either the steady-state equation (11) or the dynamic equation (12). In the existing literature it has been more common to estimate the dynamic equation, although

not exclusively so. There are, however, potentially serious econometric problems with estimating dynamic growth equations, such as equation (12), which include base period output per worker as an explanatory variable. This is due to the fact that Y_0/L_0 is necessarily correlated with A_0, the unobservable country-specific effect. As A_0 is not included in the estimated equation, but incorporated in the error term, omitted variable bias is likely to follow (see Caselli, Esquivel and Lefort, 1996). For this reason, we choose to estimate equation (11), rather than equation (12). Note, however, that this simply amounts to estimating a different variant of the same model and that both methods should give similar estimates of α_c, α_p and α_e in the absence of any estimation bias.

VI EMPIRICAL RESULTS

The variable s_k is proxied by the share of real investment in real output (I/Y) and the data are averaged over the period 1960-85. The variable s_h is proxied by the proportion of the working-age population[15] that are enrolled in secondary school (SCHOOL), with the data being averaged over the period 1960-85. MRW assume that the sum of the growth rate of technology and the depreciation rate is five percent per annum, meaning that $(n+g+\delta)$ is equal to the growth rate of the working-age population plus five percent. Output per worker (Y/L) is the level of real output divided by the working-age population, and is measured in 1985. Data on all of these variables are taken from the original MRW data set (see MRW, pp.434-6).

The data on G/Y(Barro) are from Barro and Lee (1994b) and data on G/Y(net) are calculated from various data reported in Barro and Lee (1994b). Specifically, nominal spending on education and defence as a proportion of output is deducted from the share of government consumption in output, measured in local prices. The data on price controls (PRICE) and government ownership (GOE) are from Gwartney, Lawson and Block (1996). The GOE data are averages over the period 1975-84 and the PRICE data are for 1989. Ideally, these data would be averages over the period 1960-85, however such data are not available. Although these data are perhaps less perfect than those on government consumption, it is still of interest to examine the partial correlations between

15 The working-age population is defined as those aged between 15 and 64.

these variables and economic performance. The PRICE and GOE data both include some zero observations, which can not be logged. These variables are, therefore, transformed so that the natural logarithm of PRICE is measured as ln(1+PRICE) and the natural logarithm of GOE is measured as ln(1+GOE). This is the same transformation employed by Barro and Lee (1994a) for the black market premium (BMP) which is measured as ln(1+BMP).

The results obtained from OLS estimation of equation (11) are reported in Table Two. Initial testing suggested that some heteroscedasticity may be present, therefore t-statistics based on heteroscedasticity-consistent standard errors are reported. These results are qualitatively similar to those based on standard t-statstics (the results for which are not reported). RESET tests for model specification were also performed, with the null hypothesis of correct model specification being accepted for the results reported in columns (i), (ii) and (iv), but rejected for the results reported in columns (iii) and (v). The Jarque-Bera Lagrange multiplier test for normality of the residuals was also performed, with the null hypothesis of normally distributed residuals being accepted in each case. For the sake of space, these diagnostic test results are not reported in Table Two.

For all the results reported in Table Two, government consumption is measured net of spending on education and defence. Column one gives the results obtained when investment and government consumption are measured in international prices. Although it has been argued above that this is inappropriate, the results are included for the sake of comparison. The coefficient on G/Y is negative and highly significant, which is consistent with the results obtained by Barro and his colleagues. The coefficient on GOE is positive and significant at the one percent level. As higher levels of the GOE variable represent lower levels of government ownership, this means that higher levels of government ownership are correlated with lower levels of output per worker. PRICE is insignificant.

For the results in column (i), as with all the other columns in the table, the coefficients on investment in physical and human capital, and $(n+g+\delta)$ are all significant and have the expected signs. The F tests of the restriction implicit in the model suggest that the restriction is valid in each case. The implied values of α and β, which can be calculated from the restricted regression, are similar to those obtained by MRW.

The results obtained when government consumption and investment are both measured in local prices are reported in column (ii). The most striking result is that government consumption is now positive, although insignificant. The significant negative coefficient obtained in column (i), and often obtained by Barro and his colleagues would seem to be due to measuring this variable in international prices, rather than netting out spending on

Table Two: OLS estimates of equation (11)
Dependent variable: ln(Y/L) 1985

	(i)	(ii)	(iii)	(iv)	(v)
N	65	63	87	66	89
unrestricted regression					
constant	7.326***	7.788***	7.788***	7.811***	8.860***
	(9.54)	(8.15)	(8.62)	(8.27)	(8.55)
ln(I/Y)	0.677***	1.026***	1.096***	0.932***	0.869***
	(5.90)	(4.95)	(5.34)	(3.96)	(3.38)
ln(SCHOOL)	0.484***	0.719***	0.662***	0.741***	0.747***
	(6.66)	(6.20)	(8.67)	(7.17)	(10.53)
ln(n+g+δ)	-1.689***	-2.097***	-2.348***	-1.949***	-2.188***
	(-4.93)	(-5.16)	(-6.58)	(-5.06)	(-6.38)
ln(G/Y)	-0.387***	0.157			0.047
	(-5.23)	(1.23)			(0.47)
ln(1+PRICE)	0.059	0.058		0.222**	
	(0.79)	(0.64)		(2.25)	
ln(1+GOE)	0.292***	0.447***	0.442***		
	(2.84)	(4.68)	(4.43)		
$\overline{R}^2$	0.840	0.772	0.793	0.741	0.764
restricted regression					
constant	6.280***	7.133***	6.561***	7.227***	7.721***
	(24.27)	(15.54)	(20.91)	(23.02)	(17.43)
ln(I/Y)-ln(n+g+d)	0.738***	1.075***	1.184***	0.973***	0.962***
	(6.37)	(5.40)	(6.16)	(4.34)	(4.19)
ln(SCHOOL)-ln(n+g+d)	0.511***	0.734***	0.676***	0.755***	0.755***
	(6.81)	(6.83)	(8.83)	(7.80)	(10.21)
ln(G/Y)	-0.372***	0.186***			0.076
	(-4.78)	(1.53)			(0.76)
ln(1+PRICE)	0.079	0.067		0.226**	
	(1.07)	(0.71)		(2.29)	
ln(1+GOE)	0.277***	0.437***	0.432***		
	(2.68)	(4.54)	(4.45)		
$\overline{R}^2$	0.839	0.775	0.791	0.744	0.763
F test of restriction	2.247	0.507	1.994	0.380	1.823
Implied α	0.328***	0.383***	0.414***	0.357***	0.354***
	(8.12)	(7.19)	(8.87)	(5.89)	(5.82)
Implied β	0.227***	0.261***	0.236***	0.277***	0.278***
	(7.00)	(6.30)	(7.30)	(6.52)	(7.18)

Heteroscedasticity-consistent t-statistics are given in parentheses. ***, ** and * indicate significance at the one percent, five percent and ten percent levels respectively, on the basis of two tailed tests. *F* is the test statistic obtained for the null hypothesis that the restriction implied by the model is valid. *N* is the sample size. For the elasticities, asymptotic Wald t-statistics for the null hypothesis that the relevant elasticity equals zero are given in parentheses. In column (i) G/Y and I/Y are both measured in international prices. In columns (ii)-(v) G/Y and I/Y are measured in local prices.

education and defence.[16] Knowles (2000) finds that government consumption becomes only marginally significant in the Barro and Lee (1994a) framework when it is measured in local, rather than international prices. The result obtained in this paper is even stronger. If it is accepted that government consumption should be measured in local prices, there appears to be no significant relationship between government consumption and output per worker. The coefficient on GOE remains significant at the one percent level and the coefficient on PRICE remains insignificant.

It is possible that the lack of significance of GOE and PRICE in column (ii) is due to all three government intervention variables being included in the regression equation at once (the correlation coefficient between PRICE and GOE is 0.49, which may be high enough to signal a warning about multicollinearity). To allow for this possibility, the government intervention variables are included one at a time in columns (iii)-(v). It should be noted, however, that the RESET test results, which are not reported, suggest model misspecification for the results in columns (iii) and (v). When PRICE is the only intervention variable included (column (iv)) it's coefficient is positive and significant at the five percent level. When G/Y is the only variable included it remains insignificant.[17] Therefore, we are unable to find evidence of any correlation between government consumption and output per worker, once government consumption is measured in local prices.

16 Of the studies summarised in Section Two, only Alexander (1990) and Folster and Henrekson (1998) find a significant negative correlation between government spending and growth, having measured government spending in local prices.

17 It is also of interest to ask whether government consumption would be significant if spending on education and defence were not netted out. The answer is that this variable is also insignificant, whether it is included as the only intervention variable, or included along with GOE and Price. For the sake of space, these results are not included in Table Two.

VII Conclusions

What can we conclude about the effect of government intervention on economic performance? This paper provides two thoughts on this issue with respect to government consumption. The first is that the negative correlation between government consumption and economic performance often found by Robert Barro and his colleagues depends crucially on measuring government consumption in international prices. It has been argued that to do this is misleading. Once government consumption is measured in local prices, there is no evidence of any statistically significant relationship between government consumption and output per worker.

The main argument of this paper is that government consumption measures only one aspect of government intervention, it should not be thought of as a proxy for government intervention more generally. This was illustrated by examining the East Asian economies, many of whom have interventionist, but fiscally conservative, governments. Two additional measures of government intervention have been proposed: the extent of government ownership and the extent of price controls. The data on these variables are probably not as reliable as those on government consumption, but it is still of interest to see what the available data do tell us. The empirical results suggest that high levels of government ownership are correlated with lower levels of output per worker. This implies that government owned firms are less efficient than their private sector counterparts. The evidence on price controls is not as compelling, but there is weak evidence that high levels of price controls are correlated with low levels of output per worker. However, these results should not be used to infer anything about the effect of other forms of government intervention.

Economists may well have used data on government consumption as a proxy for government intervention because such data are readily available. This, however, does not mean that the search for additional proxies should not continue. Price controls and government ownership are only two possible alternatives, there are no doubt other possibilities as well. The main point to note is that there are many dimensions to government intervention, and they may have different effects on economic performance.

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Appendix: GOE and PRICE data

The data on GOE (the extent of government ownership) and PRICE (the extent of price controls) are taken from Gwartney, Lawson and Block (1996). For each variable, each country is assigned a rating of between zero and ten. An explanation of each rating is given in the tables below.

Appendix Table One: An explanation of the data on the role of government ownership

Rating	Role of Government Enterprises in Country
10	There are very few government-operated enterprises and they produce less than one percent of the country's total output.
8	There are very few government-operated enterprises other than power generating plants and those operating in industries where economies of scale generally reduce the effectiveness of competition.
6	Government enterprises are generally present in power generating, transportation (airlines, railroads, and bus lines), communications (television and radio stations, telephone companies, and post offices) and the development of energy sources, but private enterprises dominates other sectors of the economy.
4	There are a substantial number of government-operated enterprises in many sectors of the economy, including the manufacturing sector. Most of the large enterprises of the economy are operated by the government; private enterprises are generally small. Employment and output in government-operated enterprises generally comprises between 10 and 20 percent of the total non-agricultural employment and output.
2	Numerous government enterprises of all sizes are present and they operate in many sectors of the economy, including manufacturing and retail sales. Employment and output in the government-operated enterprises generally comprises between 20 and 30 percent of the total non-agricultural employment and output.
0	The economy is dominated by government-operated enterprises. Employment and output in the government-operated enterprises generally exceeds 30 percent of the total non-agricultural employment and output.

Source: reproduced from Gwartney, Lawson and Block (1996), p.265.

Appendix Table Two: An explanation of the data on price controls

Rating	General Characteristics of Country
10	No price controls or marketing boards are present.
8	Except in industries (e.g., electric power generation) where economies of scale may reduce the effectiveness of competition, prices are generally determined by market forces.
6	Price controls are often applied in energy markets; marketing boards often influence prices of agricultural products; controls are also present in a few other areas, but most prices are determined by market forces.
4	Price controls are levied on energy, agricultural, and many stable products (e.g. food products, clothing and housing) that are widely purchased by households; but most other prices are set by market forces.
2	Price controls apply to a significant number of products in both agricultural and manufacturing industries.
0	There is widespread use of price controls throughout the economy.

Source: reproduced from Gwartney, Lawson and Block (1996), p.268.

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Director

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Mike Bleaney - growth, international macroeconomics
Indraneel Dasgupta – development theory
Norman Gemmell – growth and public sector issues
Ken Ingersent - agricultural trade
Tim Lloyd – agricultural commodity markets
Andrew McKay - poverty, peasant households, agriculture
Chris Milner - trade and development
Wyn Morgan - futures markets, commodity markets
Christophe Muller – poverty, household panel econometrics
Tony Rayner - agricultural policy and trade

Research Fellows (External)

V.N. Balasubramanyam (*University of Lancaster*) – foreign direct investment and multinationals
David Fielding *(Leicester University)* - investment, monetary and fiscal policy
Göte Hansson (*Lund University*) – trade, Ethiopian development
Robert Lensink *(University of Groningen)* – aid, investment, macroeconomics
Scott McDonald *(Sheffield University)* – CGE modelling, agriculture
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Finn Tarp *(University of Copenhagen)* – aid, CGE modelling
Howard White *(IDS)* - aid, poverty