

Economic Effects of Investment Subsidies  
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This paper will address two issues. The first is the potential magnitude of effects on the economy from investment subsidies, including the enhancement of long-run standards of living in closed and in open capital-importing economies. These outcomes depend on the elasticity of demand for capital within the country (how substitutable capital is for labor) and on supply elasticities, of saving in a closed economy, and of inbound capital in a closed capital-importing economy. They can also be altered by any behavioral effects from alternative sources of revenue. The analysis suggests that very large amounts of revenue may be foregone for relatively small gains, particularly in open capital-importing economies. The second set of issues involve the pitfalls in design of investment subsidies, including the difficulty of designing and enacting neutral subsidies that will not lead to welfare losses from distortions in the allocation of capital, and of the possibilities of negative tax burdens for debt-financed investment. Investment subsidies have generally favored equipment investment, and arguments advanced for favoring these assets are difficult to justify. Large investment subsidies for debt-financed investment can lead to very low or negative tax burdens, which are difficult to justify on any grounds.

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Explicit investment subsidies in the United States can be dated back to the early 1960s when the investment tax credit was introduced, although the accelerated depreciation methods adopted in 1954 and 1962 were also justified on the basis of economic stimulus (see Gravelle, 1994, for a history). While the investment credit was initially considered as a permanent part of the tax system, the credit was subsequently used as a short term stimulus, and then returned to being a permanent tax feature. In 1986, however, the United States repealed the investment credit and created a system with the present value of tax depreciation close to economic depreciation. Depreciation was accelerated but designed to offset inflation (although a subsequent decline in inflation reduced effective tax rates, especially for shorter lived assets that are more sensitive to inflation, as discussed in Gravelle, 2001). The revenue gains from the repeal of the investment credit were used to reduce the corporate tax rate.

According to Pechman's (1987) study of comparative tax systems, every country studied (Sweden, the Netherlands, France, Italy, Germany, the United Kingdom, Canada, and Japan) had experimented with tax incentives for investment. Pechman noted a growing disenchantment almost everywhere with investment incentives because of their distortions and inequities. Investment subsidies have tended to favor certain types of assets — plant and equipment — and have been provided in a form that is distorting even among the class of assets covered. Indeed, despite the move towards lower statutory tax rates rather than investment subsidies, plant and equipment continues to be favored over structures, as shown in Table 1 where rates are reported for Australia and the G-7.

The marginal effective tax rate reports the tax on a marginal unit of investment, and reflects both the statutory tax rate and any investment subsidies. If the statutory and marginal effective tax rates are the same, there are no investment subsidies. In 1982, when tax rates were around 50%, only

three countries (Great Britain, Italy, and the United States) had any significant subsidy for buildings, while all eight countries had subsidies for equipment; in every country, the effective tax rates were lower for plant and equipment than for industrial buildings. By 2005, statutory tax rates were around 35%. No country had a significant subsidy for buildings, but most had marginal effective tax rates for plant and equipment below the statutory rates and while the relative reduction was smaller than in 1982, in most cases it was still significant.

Table 1: Statutory and Effective Marginal Tax Rates (EMTRs), G-7 and Australia, 1982 and 2005

	Tax Rates 1982			Tax Rates 2005		
	Statutory	EMTR, Plant and Equipment	EMTR Industrial Buildings	Statutory	EMTR Plant and Equipment	EMTR Industrial Buildings
Australia	50	32	52	30	24	29
Canada	44	9	42	36	25	36
France	50	26	46	34	20	30
Great Britain	52	0	9	30	20	29
Germany	62	47	60	38	29	39
Italy	39	18	22	37	19	33
Japan	55	42	54	40	28	43
United States	50	22	37	39	24	41

Source: Data developed in Devereux, M.P., R. Griffith and A. Klemm (2002) *Corporate Income Tax Reforms and International Tax Competition, Economic Policy*, Vol. 35, pp. 451-495, provided by the Institute for Fiscal Studies [[http://www.ifs.org.uk/publications.php?publication\\_id=3210](http://www.ifs.org.uk/publications.php?publication_id=3210)]. Assumes constant interest and inflation rates.

An investment subsidy differs from the two potential alternative methods of reducing tax burdens on marginal investments — reducing tax rates and substituting a consumption or cash flow tax for capital income taxes — in several major ways.

Investment subsidies are more focused on the margin than are rate cuts, but unlike a cash flow tax they retain existing depreciation deductions and deductions for interest. Thus, while an investment subsidy has more “bang for the buck” in reducing marginal tax rates at a given revenue cost than rate reductions, it does not go so far as a cash flow tax. In a revenue neutral world, of course, all revenues must be made up by some other tax and the three approaches to reducing capital income taxes differ in the degree to which they impose lump sum taxes on the old versus increasing labor income taxes, assuming that labor income is the major alternative tax base. Cash flow taxes still yield substantial revenues and thus require less in the way of additional taxes from other sources when substituted for an income tax; asset values, however, fall. Reducing tax rates directly reduces revenue and requires, for the same effective tax rate on new investment, more additional taxes. Investment subsidies occupy an intermediate position.

Both rate cuts and true cash flow taxes are neutral with respect to assets of different durabilities and neither provide additional benefits to debt-financed investment. When inflation is present, debt finance is typically subsidized in an income tax, so that reducing the corporate tax rate or replacing it with a cash flow tax reduces that subsidy. Investment subsidies, while they can be designed to be neutral, typically have not, and as noted above, have mainly favored equipment; they apply to debt-financed as well as equity-financed investments.

Considering an investment subsidy, therefore, leads to two issues for investigation. The first is, how effective the subsidy (or a rate cut) is in increasing future well-being in a society; that is, what might a country expect to gain from a subsidy? The second is, if a reduction in marginal tax rates is desired, what are the benefits and costs of choosing an investment subsidy over other alternatives, such as rate reductions or partial substitution with a cash flow tax? And, how might investment subsidies be designed to be most efficient?

## Aggregate Effects of an Investment Subsidy on the Economy

What are the potential gains to a society from reducing the tax burden at the margin for an investment subsidy? One important aspect to considering these effects is to recognize that it is not the overall effect on output that matters, but rather the level of sustainable consumption.

### *A Simple Base Case*

To explore the potential effects of a general investment subsidy on steady-state welfare, consider a simple profit maximizing problem with price as the numeraire:

$$(1) \pi = Q(K, L) - cK - wL$$

where  $\pi$  is profit,  $Q$  is output,  $K$  is capital,  $L$  is labor,  $c$  is the user cost of capital, and  $w$  is the wage rate. In this simple case, assume a Cobb-Douglas production function of the form  $Q = AK^\alpha L^{(1-\alpha)}$ . The cost of capital is the sum of the pretax return  $r$  and the depreciation rate  $\delta$ , that is  $c = r + \delta$ . In the presence of taxes the cost of capital is:

$$(2) c = r + \delta = (R + \delta)(1 - uz - k)/(1 - u)$$

where  $R$  is the required after tax rate of return,  $u$  is the statutory tax rate,  $z$  is the present value of depreciation deductions and  $k$  is an investment credit without a basis adjustment (that is, an investment credit that does not reduce the basis for depreciation). We assume initially that  $z$  is equal to economic depreciation ( $\delta/(R + \delta)$ ) and set values typical of a modern economy, with  $R = .05$ ,  $\delta = .07$ , and  $u = 0.3$ . To reduce the cost of capital by 10 percent without a basis adjustment requires an investment tax credit rate of 8.25% (10% times  $(1 - u\delta/(r + \delta))$ ). Note that this is a very large investment subsidy given the 30% tax rate and the depreciation rate; the effective tax rate  $(r - R)/r$  falls by more than half, from 30% to 12.7%, a 57.7% reduction.

We assume domestic labor supply and the after-tax required return,  $R$ , to be fixed (and thus the change in the cost of capital is exogenous). A fixed  $R$  responds to a perfectly elastic supply of capital. Calibrate the model with price as the numeraire, and with  $\alpha$ , the share of output accruing to capital in either pre-tax return or depreciation, as 0.3. With these values, the capital stock is 2.12 times output (since  $cK = \alpha Q$ ), a reasonable value for business capital. In order to estimate the effect of changing  $c$  to  $0.9c$ , we take the first order conditions from equation (1) with respect to  $K$  to find the relationship between  $K$  and  $c$ , which, after some rearrangement and dividing by new values (denoted with an asterisk) by the old values:

$$(3) \quad (K^*/K) = (.9)^{1/(\alpha-1)}$$

which yields an increase in the capital stock of 16.2%.

Although this appears to be a large increase in the capital stock, because capital is only one of the inputs and, to a lesser degree, because of the declining marginal factor productivity, the gain in output is much smaller:

$$(4) \quad (Q^*/Q) = (K^*/K)^\alpha$$

or an increase in output of 4.2%.

Measuring a gain in gross output however, does not allow for the need to use some of the additional output to replace the larger capital stock. Given the values used in our example, the capital stock in the economy is 2.12 times the output. Net output, after accounting for depreciation, is about 85% of gross output. Out of the 4.2% increase in output, more than half, 2.4% must be diverted to replacing the increment of depreciating capital stock. As a result, the percentage increase in net output is 2.2%. But even this rate of increase is not sustainable. To sustain a higher level of output the new increment of capital stock must also grow. That is, net steady state investment must

be subtracted to determine the steady state sustainable consumption. Assuming a steady state growth rate of 3%, the combination of net and replacement investment accounts for a 3.4% increase in output, leaving only a 1.5% increase in sustainable consumption, equivalent to six months of ordinary growth.

This analysis, incidentally, could also be applied to a rate cut that yielded the same reduction in the cost of capital; the revenue cost would be different but not the economic effects.

The effects for an open capital-importing country are even smaller. In this case, not only must part of the output be used to replace and grow the higher capital stock, but investors must ultimately realize their after-tax rate of return on the new increment of investment. If the rate of return is 5% and the growth rate is 3%, an additional 2% of the capital stock is required to compensate foreign investors in the steady state; the increased output used for replacement investment, net investment, and payments to foreign investors accounts for 4.1%, or 90% of the increase in output. As a result, domestic consumption increases by only 0.6%, equivalent to slightly over two months normal growth.

This illustration, using reasonable values for mature economies, indicates that capital deepening through even significant reductions in the effective tax rate via investment subsidies can only produce limited effects on output. Part of this effect occurs because as capital is added, the added productivity of that capital declines, while the amounts needed to sustain the capital stock grow linearly with the capital stock. Indeed, it is well known in growth theory that it is possible for the capital stock to become too large so that more capital, even in a closed economy, can reduce steady state consumption. This barrier to gain is even more pronounced in an open economy case where the return paid to foreign investors also grows linearly.

Despite these limited effects, however, the scenario just produced is likely to be overly optimistic for several reasons: consumption is further reduced due to debt finance, the unitary

elasticity implied by the Cobb Douglas production function is too high and the supply of capital is not perfectly elastic.

There are some other effects that are not considered. First, the possibility of imperfect product substitution, was found by Gravelle and Smetters (2006) to reduce capital mobility in the same way as imperfect portfolio substitution and thus could play a role in reducing the effectiveness of any subsidy. Second, in a capital importing country, if the foreign investors are from countries that use a credit system, which include important investing countries such as the U.S., the UK, and Japan, the investment subsidies may have less effect as additional home country taxes may offset part of the incentive. Finally, the analysis does not consider any effects from measures taken to offset the revenue losses from investment subsidies. If labor supply declines as a result of increased taxes on labor income, this decline could offset any output effects (although most empirical evidence suggest labor is relatively inelastically supplied). Revenue losses made up by incurring additional debt would compete with capital used for investments that contribute to future well being.

#### *Debt Finance*

Debt finance reduces the steady state consumption in the open capital-importing country because foreign investors with debt finance receive the pretax nominal interest rate, while the discount rate of the firm allows for a tax deduction. As an illustration, suppose the nominal interest rate is 8% and the share debt financed is a third. The payment to foreign investors is increased by 8% times the tax rate times the share debt financed, in this case by about 0.2% of consumption, reducing the steady state gain to consumption by about a third, from 0.6% to 0.4%.

#### *The Factor Substitution Elasticity*

Turning to the next issue, the Cobb-Douglas production function's unitary elasticity, while often used in simple models, is, based on recent evidence, probably high. (Note: These elasticities are negative but are reported in absolute values). The development of this literature is surveyed in Hassett and Hubbard (2002) and Chirinko (2002) and it largely related to the United States. In early



empirical work, investment studies were examining the flow, not the stock of capital. Initial studies used an adjustment process between actual and desired capital stock, but this could capture accelerator effects, and when critics isolated user cost, they found negligible effects, with investment elasticities ranging from 0 to 0.3. Models incorporating adjustment costs and using  $q$  (market value to replacement cost) also did not do well and produced implausible adjustment parameters. In general most studies using aggregate investment data found very small effects of permanent changes in tax variables. The problem with these studies was the tendency of many variables to move together over the business cycle. Subsequent studies used panel investment data and in some cases found elasticities of around 0.6, although other studies found estimates of 0.18 to 0.35.

Other studies used data on the capital stock, with results ranging from zero to slightly over 1, although most of these studies fell in the neighborhood of 0.3 to 0.7.

Subsequent to these reviews some additional research has been done. Chirinko, Fazzari, and Meyer (2004) used a long panel data set on firms and estimated an elasticity of 0.4. Barnes, Price, and Barriol (2008) found the same value for the UK using a similar approach. Chatelain, Generale, Hernando, von Kalckreuth, and Vermeulen (2002) found an elasticity of 0.63 for Germany, 0.38 for France, 0.32 for Italy and a statistically insignificant 0.09 for Spain. An earlier study by Caballaro (1994) using capital stock data had found a unit elasticity and a similar value was found for Canadian data by Schaller (2006), but Smith (2008) found a value of 0.4 for the UK using Caballaro's approach as well as an industry level data set. (Caballaro and Schaller excluded structures which in earlier studies were found to be less responsive than equipment.) Finally, in a study of a small open economy, Coulibaly and Millar (2007) estimated an elasticity of 0.8 for South Africa; they also suggested that the insignificant elasticity they obtained for the embargo period may reflect the difference between a closed and open economy. A earlier study by de Wet and Koch (2004), however, using firm level data, found an elasticity of 0.18.

The institution in the United States of a temporary bonus depreciation for 2002-2004 provision provided an opportunity to examine the effect of a temporary provision which should have relatively powerful effects, in theory. These studies exploited the differential effects in cost of capital of allowing 50% of the cost of equipment to be expensed, across asset type. Cohen and Cummins (2006) found little evidence for a significant effect. They suggest several potential reasons for a small effect. One possibility is that firms without taxable income could not benefit from the timing advantage. In a Treasury study, Knittel confirmed that firms did not elect bonus depreciation for about 40% of eligible investment, and speculated that the existence of losses and loss carry-overs may have made the investment subsidy ineffective for many firms, although there were clearly some firms that were profitable that did not use the provision. Cohen and Cummins also suggested that the incentive effect was quite small (largely because depreciation already occurs relatively quickly for most equipment), reducing the user cost of capital by only about 3%, that planning periods may be too long to adjust investment across time, and that adjustment costs outweighed the effect of bonus depreciation. Knittel (2007) suggests that firms may have found the provision costly to comply with, particularly because most states did not allow bonus depreciation. A study by House and Shapiro (2006) found a more pronounced response to bonus depreciation, given the magnitude of the incentive, but found the overall effect on the economy was small, which in part is due to the limited category of investment affected and the small size of the incentive. Their differences with the Cohen and Cummins study reflect in part uncertainties about when expectations are formed and when the incentive effects occur. Cohen and Cummins also report the results of several surveys of firms, where from 2/3 to over 90% of respondents indicated bonus depreciation had no effect on the timing of investment spending.

It is not clear what the implications of the studies of bonus depreciation are for the factor substitution elasticity, but this provision was one that was expected, because of its fire-sale nature, to have a large effect, and the results do not support a great deal of responsiveness.

While the research has produced a range of estimates of the factor substitution elasticity, most of the studies suggest a value of less than unity, perhaps considerably less than unity.

Table 2 compares in columns (2) and (3) the estimates of the effects for the Cobb Douglas unitary elasticity case with a case of a constant elasticity of substitution as embodied in the following production function:

$$(5) Q = A [aK^{(1-1/\sigma)} + (1-a)L^{(1-1/\sigma)}]^{1/(1-1/\sigma)}$$

Table 2: Percentage Change in Output and Consumption from Reduction in Cost of Capital by 10% (Equivalent to a 57.7% Reduction in Effective Tax Rate), For Different Values of the Factor Substitution Elasticity  $\sigma$  and the Savings Supply Elasticity  $\epsilon$

	$\sigma = 1$ $\epsilon = \infty$	$\sigma = 0.5$ $\epsilon = \infty$	$\sigma = 1.0$ $\epsilon = 3$	$\sigma = 0.5$ $\epsilon = 3$	$\epsilon = 0$
Capital Stock	16.2	7.7	12.3	6.9	0.0
Gross Output	4.6	2.2	3.7	2.0	0.0
Net Output	2.2	1.2	2.1	1.1	0.0
Sustainable Consumption: Closed Economy	1.5	0.7	1.2	0.6	0.0
Sustainable Consumption: Open Economy*	0.6	0.3	-0.1	0.0	-3.1

\* Estimates assume all equity finance. With an 8% interest rate and 1/3 debt finance, the gain would be smaller, for example 0.4% of consumption in the case with  $\sigma = 1$  and  $\epsilon = \infty$  and 0.2% of consumption for  $\sigma = 0.5$   $\epsilon = \infty$ . Similar adjustment would be made for other cases.

Source: Author's calculations, see text.

The derivation of capital demand is somewhat more complicated and is presented in an appendix.

The results, for a substitution elasticity of 0.5, show that a lower factor substitution elasticity can significantly reduce the long term gains to standard of living, cutting them approximately in half.

Thus in a closed economy, the long run percentage increase in consumption is only 0.7 percent; for the open economy, the gain is only 0.3%. With debt finance, the gain in an open economy is 0.2%.

### *Savings Responses*

In the cases considered thus far, the after tax rate of return,  $R$ , is fixed, which assumes that the supply of capital is infinitely elastic. This assumption is probably unrealistic in either a closed or open economy. In introducing imperfectly elastic savings response into the model, we introduce a new equation and a new unknown,  $R$ , the required after tax return. The equation is for the supply of capital:

$$(6) K = BR^\epsilon$$

The demand for capital from the first order condition of the production function is equated to the supply to solve for  $R$ , which in turn determines  $c$ . In the cases already considered,  $\epsilon$  is infinity.

The issues differ between a closed and open capital-importing economy.

#### Closed Economy.

In a closed economy, the supply of capital depends on saving behavior of individuals in that economy. As investment subsidies increase demand for capital in a fixed supply world, the after tax return to savers rises. Only if that rise induces additional savings can the aggregate capital stock expand. (Capital can also be diverted from other sectors, such as owner occupied housing, but the gain in the business sector is offset by the loss in the remaining sector. (A small efficiency gain is possible, but not necessarily the case, as discussed below.)

In theory, even the direction of an effect on savings of an increase in the rate of return is unclear. An increase in the rate of return can lead to more savings or less savings depending on income and substitution effects. The outcome depends on a number of important issues and model assumptions. In addition, it is not clear that individuals behave as predicted by current inter-temporal savings models, which require very complex decisions; they may use rules of thumb such as a fixed share of income (with no effect on savings) or a target future accumulation (where

increases in the rate of return allow one to save less to achieve a target). This view of savings is consistent with empirical evidence over time in the United States that suggests savings rates are relatively steady for long periods rather than reflecting the dramatic shifts that would be expected from tax policy and other changes.

Some formal growth models predict a substantial effects on savings. The earliest model of economic growth, the Solow model, simply took the savings rate to be fixed. The Solow model with its fixed savings rate was consistent with both a steady state growth in output per capita in the U.S. economy, as well as a savings rate that seemed to show no trend (see Gravelle 1994, chapter 1, for a discussion of time series savings estimates). Economists, however, subsequently developed intertemporal growth models. There are essentially two forms: the infinite horizon or Ramsey model, and the overlapping generations life cycle model (OLG) model. (These models, along with bounded rationality models that rely on rules of thumb, are reviewed in Bernheim, 2002.)

While these models are used in academia, they are not used by forecasters, whose cyclical models begin with sticky prices and which eventually exhibit, in most cases, Solow model characteristics. In the infinite horizon model, by contrast, the long run supply of savings is perfectly elastic. The infinite horizon model is a special case of the OLG model, where agents take into account the utility of their descendants, while the OLG model has either no bequests or bequests motivated by other considerations. Both models assume a degree of knowledge, sophistication and foresight that most ordinary savers are unlikely to have. It is not clear how the Ramsey model, intended by both its originator and those who refined it as a social planner's guide, came to be considered a realistic description of individual behavior. It does not account for marriage, and so cannot capture the possibility that one's descendants will receive bequests from others. More importantly, it reaches corner solutions in any economy where there are many jurisdictions with different types of tax rates (such as the states in the U.S. or countries around the world). Since we

don't observe one country or one state owning all of the capital, the model appears at odds with reality.

The overlapping generations model does not create the corner solutions, although it still assumes an extraordinary degree of sophistication and knowledge. Unlike the infinite horizon model, income effects can occur, and the extent to which capital income taxes affect savings and output depend on how the revenue is being made up and on numerous features of the models (see Gravelle 2002). As shown by Auerbach and Kotlikoff (1967), Gravelle (1991), and Engen, Gravelle, and Smetters (1997), while the replacement of a capital income tax with a consumption tax tends to produce a large savings response, the replacement of capital income taxes with wage taxes does not, and can cause it to decline. Hence, the effects of investment subsidies in this model depend on how closely investment subsidies reflect a consumption type approach compared to a rate reduction approach.

This closeness depends in part on the form of the investment subsidy. For example, a partial expensing in the long run is similar to a consumption tax (except that it continues to allow interest deductions) and in an all-equity world would be equivalent to partial replacement of an income tax with a cash flow tax. The investment credit is quite different, however, because rather than moving tax liability into the future, it adds a layer of tax subsidy. Gravelle (2008) shows that much of the effect of a shift to a consumption tax on saving in a life cycle model is simply due to the need to increase savings to account for the lump sum loss in value imposed by a consumption tax as the government effectively becomes a partner in the investment. Since the consumption tax offers a deduction up front and imposes taxes on the return of as well as to capital in the long run, an increase in savings is required to simply restore the asset value. The value of assets falls by the tax rate (if the tax rate is 30%, asset values fall by 30%) and savings should eventually increase from the current level of to  $1/(1-t)$  times the current level.

In our example, the investment credit rate is 8.25%, and thus asset values would fall by that amount. Suppose the same subsidy were achieved by partial expensing. To determine the level of partial expensing necessary to achieve the same result as the investment credit we equate the cost of capital with a share,  $x$ , expensed to the cost with an investment credit  $k$ :

$$(6) (R+\delta)(1-u(x+(1-x)z))/(1-u) = (R+\delta)(1-uz-k)/(1-u)$$

The results indicate that the share expensed would be 68%. Since the tax rate is 30%, the fall in asset value should be 0.3 times 0.68 or 20.4%. Savings would rise by 9% due to the timing effect with the investment credit and by 26% for the expensing provision. Thus, an investment credit has an effect through this route of a third of the expensing approach, suggesting that the results from a life cycle model would exhibit savings responses that are much smaller than those for a consumption tax.

One could also make a case that savings responses in a closed economy are much less because the lifecycle model is an unrealistic depiction of behavior that is at odds with empirical evidence and that rule-of-thumb models are more appropriate. This view is supported not only by the evidence on the relative constancy of the savings rate in the United States over many years, but also by Madrian and Shea (2001) who found that participation in employer savings plans was strongly affected by the default (opt in or opt out), behavior that is entirely inconsistent with the optimizing behavior assumed in the life cycle model. In that case a savings elasticity closer to zero would be expected.

#### Open Capital-Importing Economy

In an open economy, the supply of capital depends on international capital mobility. Although models often assume capital to be perfectly mobile, there is considerable empirical evidence and theoretical reason to doubt such a perfect substitutability. Foreign jurisdictions may appear more risky since investors are less certain about the risk environment in other countries. There may also be some exchange rate risk. Individuals and firms have strong home biases. Finally studies of the

mobility of equity capital have suggested that these capital flows are elastic, but far below infinity. Gravelle and Smetters, based on a review of evidence choose a portfolio substitution elasticity that they considered somewhat high of 3. A study by de Mooij and Ederveen (2003) presents a meta analysis of 25 research studies and concludes with a central semi-elasticity of -2.4 with respect to a change in the tax rate. In equation 6, if the aftertax return were  $r(1-t)$  where  $r$  is the pre-tax return and is fixed, taking logs and differentiating with respect to the tax rate would indicate that the percentage change in the supply of capital is equal to  $\epsilon$  times the  $dt/(1-t)$ . Thus, to convert this elasticity to the form used in the model the 2.4% elasticity would have to be multiplied by  $(1-t)$  or, in this case 2.4 times 0.7 or an elasticity of 1.7. It's possible, however, that this elasticity has increased over time.

Table 2 considers two elasticities, an elasticity of 3 and an elasticity of zero. For the closed economy, the higher elasticity lowers the gain in both the Cobb Douglas and the CES of 0.5 case. The elasticity of zero eliminates any gain. For the open economy, however, the elasticity of three causes a steady state loss in consumption. This outcome is not surprising as the optimal tax rates are higher when inbound capital flows are less than perfectly elastic; for a simple tax rate change, the economy begins to lose when tax rates fall below  $1/(1+\epsilon)$  or in this case 25%. Maximizing  $F(K) - r(1-t)K$  with respect to  $t$ , and recognizing that  $r$  and  $K$  are functions of  $t$ , and  $r$  is the marginal product of capital yields this result. When inbound capital is very elastic the optimal tax rate for maximizing consumption is close to zero while as it becomes very inelastic, the tax rate rises towards 100%

If inbound investment is perfectly inelastic, the tax cut simply increases the after tax return to foreign investors, in this example, by up to 3% of consumption.

### *Conclusion*

This analysis is highly suggestive that attempting to improve welfare through investment subsidies is unlikely to be very successful. In a closed economy, results are likely to be quite small



because so much of the output gain must be devoted to steady state investment, and some of the tax reduction (perhaps most of it) will only increase after tax returns to savings. If the gains appear limited in a closed economy, they are even more limited in an open capital importing economy. At best they are likely to be negligible, and there is a strong likelihood that welfare will decline as the benefits of the lower tax rates are captured by foreign suppliers of capital in higher rates of return. Most countries are in an intermediate position, and that position can also be affected by reductions of outbound investment, as most outbound investment is probably not effectively taxed in the home country. To the extent capital growth financed by reductions in outbound investment are driven domestic savings does not increase, and output gained domestically is lost abroad (there may be some welfare gains, however).

These results are affected by beginning assumptions. Let us consider, for example, a country with a smaller capital-output ratio. If we reduce that ratio by slightly over 15% by raising the after tax return to 7%, the sustainable consumption in a closed economy under the most optimistic case (unitary factor substitution elasticity, infinite supply elasticity) rises to 2.1%, although it rises by only 0.8% in the open economy case because of the higher rate of return. If we reduce it by reducing the capital income coefficient to 25%, the effect on consumption in the steady state in the most optimistic case is only 1.1% in the closed economy and 0.5% in the open economy. Thus these results seem robust to significant variations in beginning assumptions, and that is particularly the case for the capital importing country. Note that these effects are for the optimistic case and would be reduced similarly to the base case with reductions in factor substitution and savings elasticities.

### **The Choice and Design of Investment Subsidies**

Investment subsidies can be contrasted with two alternative ways of reducing the cost of capital: a rate reduction and a shift to a cash flow consumption tax. Investment subsidies occupy an intermediate position between the two. They focus, for the amount of revenue loss, more at the

margin than corporate rate cuts, but less than consumption taxes. More incentive can be obtained per dollar of revenue loss with an investment subsidy (an issue referred to as “bang for the buck”) than with a rate cut. Both corporate rate cuts and consumption tax shifts differ from investment subsidies in two important, and presumably desirable ways: they are neutrality across assets and they do not create or add to negative effective tax rates for debt financed investment. As noted above, the consequences for savings in the closed economy environment in the steady-state can differ as well, depending on the design of the investment subsidy.

Before turning to these issues, it is important to consider that a shift to a consumption tax entails extremely challenging issues of transition and design issues that are far less serious with investment subsidies and rate cuts. In particular, if the objective is to achieve a revenue base that is not significantly smaller than the capital income tax it is replacing, depreciation deductions for existing capital assets, as well as interest deductions and deductions for cost of goods sold on hand must be denied. The latter is a particularly serious barrier (see Gravelle 2006 for a discussion of these issues). Thus the remainder of this discussion, where comparison is appropriate, will largely focus on the alternative of a rate reduction.

#### *Role of the Corporate Tax in the Tax Structure*

There is one important aspect in which rate cuts are different from investment subsidies: investment subsidies apply to all businesses, while corporate rate reductions apply only to incorporated businesses. For reasonable reductions in the corporate rate, this difference can be advantageous, because corporate equity tends to bear the heavier taxes. For very large rate reductions, however, problems can develop in the use of the corporate tax as a shelter, an issue that is particularly important in the United States where the restrictions as to what classification a business is in are relatively lax. Thus, if there is a significant individual tax meant to apply to capital income, lowering the corporate rate too far can induce tax sheltering activity (which increases administrative burdens) and cause individual income tax revenue losses.

### *Bang for the Buck*

Although investment subsidies are often perceived as provided more “bang for the buck” Gravelle (2008) finds an investment credit to be almost as costly per dollar as a rate reduction. This effect can be explored by examining an investment tax credit.

$$(7) c = (R+\delta)(1-uz-k)/(1-u)$$

The percentage change in  $c$  with a change in  $k$  is equal to  $-dk/(1-uz)$ , and if  $e$  is the elasticity of investment,  $I$ , with respect  $c$ ,  $dI = -eIk/(1-uz)$ . Since the revenue loss is  $kI$ , the ratio of stimulus to revenue loss is  $e/(1-uz)$ .

With a rate cut we obtain, using the same method,  $dI = -eI du (1-z)/[(1-u)(1-uz)]$ . The revenue loss, with economic deprecation is  $rdu/(1-u)K$ , where  $K$  is the capital stock. Since  $I$  is equal  $(g+\delta)K$  the ratio of stimulus to revenue loss given that  $z$  is  $\delta/r+\delta$  is  $e(g+\delta)/[(R+\delta)(1-uz)]$ . Thus, the ratio of the cost, beginning with a system with economic depreciation, is  $(g+\delta)/(r+\delta)$ . In our illustration, for example, this bang for the buck would be 0.83. One reason that investment subsidies tend to lose so much revenue that they don't really have powerful bang for the buck compared to a rate reduction is that they aren't confined to new investment; they are also granted for replacement investment. In fact, for equipment, which is the most typical target of investment subsidies, if the average depreciation rate is 15% the ratio of cost is 0.9.

### *Neutrality*

One of the problems that occurs with investment incentives historically is that they are not neutral across assets, partly because they have tended to be restricted to equipment, and partly because they have often been granted in the form of an investment credit. Investment credits have some significant timing benefits compared to accelerated depreciation and thus tend to be attractive as investment subsidies. They tend to produce, for a permanent subsidy, a smooth pattern of revenue loss over time. Depreciation tends to have a very uneven pattern. At the extreme, partial expensing involves a very large short run revenue cost that then declines over time as future depreciation

deductions are foregone. Accelerated depreciation also has a very uneven pattern, where it rises and then declines.

Investment credits are not neutral, however, even if they were uniformly applied. For neutrality, the cost of capital should change independent of the depreciation rate. But as can be seen from differentiating equation (7), the change in cost of capital is  $-(R+\delta)k/(1-u)$ . This effect was recognized in the U.S. investment credit, which limited the treatment for very short-lived assets.

This treatment is somewhat moderated if the credit has a basis adjustment, that is depreciation is not allowed for the amount of the investment financed by the credit. In this case:

$$(8) c = (R+\delta)(1-uz)(1-k)/(1-u)$$

In this case, the change in  $c$  is  $-\{R/(1-u)+\delta\}k$ . The influence of the depreciation rate is lessened, but remains.

There are neutral investment subsidies. One, as noted earlier, is partial expensing where a fraction  $x$  is deducted immediately and the remainder is depreciated..

$$(9) (8) c = (R+\delta)(1-u(z(1-x)+x))/(1-u)$$

In this case, the change in  $c$  with  $z$  equal to economic depreciation is  $-xuR/(1-u)$ .

As noted earlier, partial expensing has the advantage of being neutral but it is often not practical from a budgetary standpoint as a permanent provision, outside of a formal cash flow tax, since its short run revenue cost is so large. (In a cash flow tax, this revenue cost is offset by the loss of existing depreciation and interest deductions).

It is possible to structure an investment credit as a neutral policy (given existing economic depreciation) by allowing it only for investment in excess of depreciation. This produces a smooth revenue pattern (although the credit rate would have to be much larger to achieve the same overall reduction in cost of capital). It is neutral because an additional dollar of investment will lead to additional depreciation deductions,  $z$  in present value, that will reduce the credit. Thus, the cost of capital is:

$$(10) c = (R+\delta)(1-uz-k(1-z))/(1-u)$$

and the change in the cost of capital is  $-kR/(1-u)$ .

Because of this anticipation of future depreciation effects, this approach does not gain in ‘bang for the buck’ as might initially be imagined, but it will create a smoother revenue pattern. Firms may, however, reorganize to reduce the depreciation floor, so this approach does have some avoidance problems.

The investment credit could also be made neutral by varying the rate across assets, with lower rates for shorter lived assets. This approach would require estimates of the components of the cost of capital, unlike approach such as expensing or allowing credits for investment in excess of depreciation, which have an automatic tendency to move towards neutrality.

While one could design an investment subsidy that is not neutral, most subsidies, as indicated in this paper, favor equipment, and the form most commonly used, the investment credit, favors short lived assets within equipment. (No subsidy approach is without some type of flaw, however). No arguments have been advanced to justify the favoring of shorter lived assets within the equipment category, but there have been discussions of rationales for favoring equipment over structures. Gravelle (2001) reviews a number of these arguments. Some of these arguments, such as those that equipment is more “productive” are dismissed by standard economic analysis. Arguments were also made in the United States that buildings were favored because they used more debt and benefitted from other characteristics, which should be dismissed on factual grounds according to Gravelle. Another argument, that tax lives may be too short due to technological obsolescence, should justify more accurate measures of depreciation and non-explicit subsidies; moreover, short lived assets that becomes obsolete do have a safety mechanism in that the remainder of the cost of equipment that is scrapped can be deducted.

One argument that did, however, receive some attention in the economics literature was the argument that equipment investment produces some externalities, such as increasing labor skill

through “learning by doing.” DeLong and Summers (1991) presented a study that indicated that investment in equipment as a share of output was correlated with economic growth; this study was, in this author’s view, successfully challenged by Auerbach, Hassett and Oliner (1994). One other argument, made by Judd (1997), suggested that equipment-producing firms are imperfectly competitive. Such a view would seem to be less easily justified in the global economy, and it almost certainly would not apply with equal force to all assets. To identify goods, measure the effects of imperfect competition, and develop reasonable subsidy offsets is probably beyond the ability of government interventions.

#### *Negative Tax Rates and Debt Finance*

Reducing the corporate tax rate benefits equity investment that is heavily taxed. It also reduces an existing subsidy for debt, which arises when inflation is present due to the deduction of the inflation premium (or the failure to tax gain from repaying debt in cheaper dollars). An investment subsidy, on the other hand, can reduce the tax burden on equity below zero and will reduce the burden on debt (at the firm level) to a negative.

With respect to equity investments, while some forms of subsidy can never reduce a tax below zero (such as accelerated depreciation or partial expensing), an investment credit can, particularly when tax rates are low and particularly for less durable assets. In our earlier example, the investment credit of 8.25% reduced the overall tax rate to 12.7%, but if applied only to equipment, with a depreciation rate of 7%, the tax rate would be a negative 4.5%. If applied to a shorter lived asset with a depreciation rate of 33%, the tax would be a negative 87.8%. There are increased possibilities of negative tax rates when depreciation is already accelerated, since negative tax rates occur when the present value of tax depreciation deductions plus the investment subsidy reach the equivalent of expensing (i.e.  $uz + k = u$ ). For example, the present value of the most common asset class in the United States tax system (a 7-year class with accelerated depreciation) is 87 cents on the dollar. At

a 35% tax rate, the value of depreciation is 30.5%, leaving room for only a 4.5% investment credit before tax rates become negative.

These effects are more pronounced for debt. Any investment subsidy will produce a negative tax rate. Suppose that the asset being considered is debt financed and that the interest rate is such to produce an after tax cost of capital of 5%, that is the interest rate is  $.05/(1-t)$ , or 7.14%. In this case, the tax rate at the firm level before the subsidy is zero, but the effective tax rate with an 8.25% credit is a negative 24%. If applied only to equipment assets with a depreciation rate of 15%, the tax rate would be a negative 49%.

These outcomes are even more pronounced if we begin with inflation. For example, consider a fairly low inflation rate of 2%. In order for a firm to have a real discount rate of 5% with this inflation rate, the interest rate must be 10%, so that the after tax nominal rate is 7% (after allowing for deduction at a 30% rate) and the real rate is 5%. However the real interest rate is 8% (10% minus 2%). Without any subsidy this inflation effect produces a negative tax rate of 12% rather than the zero tax rate which would be expected for debt finance. With the 9.25% investment credit, there is a negative tax rate of 40%. If applied only to equipment, the rate is a negative 67%.

In a closed economy, if interest is taxed to the individual, some of this tax may be recouped on the individual side, although if the corporate and individual tax rates differ, negative tax rates can remain. For an open capital-importing country, however, the corporate level is the only level at which the tax applies for that country. .

## **Conclusion**

Two important conclusions emerge from this analysis. First, modeling of the effects of subsidies, whether granted via rate reductions or investment subsidies, suggests that little gain in long run welfare can be expected and, indeed, for a small open economy a country can easily make itself worse off. Second, there are many difficulties to be encountered in designing investment subsidies,

which can maintain existing distortions (such as those favoring debt finance) and can introduce distortions across assets.

### **Appendix: A CES Production Function and Savings**

To solve the model for a CES, it is necessary to calibrate the values of A and a in equation (5) to fit the same share of capital income for the Cobb Douglass case (i.e. to generate the same capital stock relative to output).

To calibrate for a, we take the first order conditions for capital and labor from equation (5) and dividing, obtain the capital labor ratio:

$$(A1) K/L = [aw/(1-a)c]^\sigma$$

K is known through the factor share formula ( $cK = \alpha Q$ ), with Q normalized to 1, and setting the wage rate initially to 1, the value of labor is 0.7. Thus equation (A1) has one unknown, a. Once the value of a is determined, equation (5) can be used to solve for A, since Q, K, L, and a are known. Once calibrated, take the first order condition for capital from equation (5) which, after some manipulation is:

$$(A2) K = [ \{ (Aa/c)^{\sigma-1} - a \} / (1-a) ]^{\sigma/(\sigma-1)}$$

Then solve for Q based on the production function.

In the imperfectly elastic savings model, R becomes a variable. B must be calibrated by equating capital demand (which is equal to the initial value of K) with capital supply, where all the other values are known. To solve the model, these values are equated, producing one equation with one unknown (R). Once R is determined, capital stock and output can be determined.



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