The Impact of Tax Reform in Modern Dynamic Economies

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A theoretical case for consumption taxation, based on the inverse elasticity and productive efficiency principles from optimal tax theory, is presented for economies with perfect competition. Tax reform analyses often ignore issues of imperfect competition, risk, and human capital. These are all important elements of any modern economy. Our theoretical arguments are then extended to allow for imperfect competition, risk, and human capital. Including these features in our analysis at least doubles and often triples the estimated gains from switching to consumption taxation. Furthermore, the gains from consumption tax reform are more evenly distributed than conventionally thought.

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Tax policy in the United States since WWII has been based on the principles of an income tax. Its intellectual foundation lies in the Haig-Simons approach to income taxation - define income properly and tax it. However, economists over the past thirty years have increasingly argued for moving away from income taxation and towards consumption taxation. Tax reform debates often focus on the choice between income and consumption taxation.

The key issue is the taxation of savings and investment[1]. Many theoretical analyses have argued for a zero long–run capital income tax rate. Early arguments, such as Feldstein (1978), Atkinson and Sandmo (1980), Auerbach (1979), and Diamond (1973), relied heavily on separability assumptions and identical agents in each cohort. Judd (1985b) proved that the optimal long-run capital income tax rate is zero even when tastes are not separable and agents have different tastes and abilities. Others have explored taxation issues in models of economic growth. Eaton (1981) showed that capital income taxation reduces an economy's long-run growth rate and Hamilton (1987) demonstrated that asymmetric treatment of different kinds of investment has a high efficiency cost. Judd (1999) generalized the analysis in Judd (1985b) to include human capital investment, government expenditure, and various forms of growth. All of these analyses argue strongly against taxation of asset income in the long run.

The increasingly robust theoretical case against asset income taxation has been supplemented by estimates of how much the economy would benefit from tax reform. Studies such as Jorgenson and Yun (1990) and Auerbach (1996) show that switching to consumption taxation would significantly increase savings and labor supply, and improve productivity. Jones et al. (1993) uses computed examples to show that asset income should be small even in the intermediate run. Both theoretical and empirical work shows that a pure income tax system is far from best in terms of aggregate output.

The U.S. tax system has also evolved into a hybrid system combining features of income and consumption taxation[2], but the presence of the corporate income tax and the limited nature of savings incentives still gives the current tax system a strong income tax flavor. Most economists agree that moving completely to consumption taxation would improve aggregate

[1]We must immediately clear up a semantic problem which can arise in discussing the taxation and nontaxation of asset income. In this paper, any comment on whether a tax system taxes asset income implicitly refers to the effective tax rate on new investment. In this sense, the current tax system taxes asset income, but the Hall-Rabushka Flat Tax and most other consumption tax proposals do not tax asset income.

[2]See Aaron et al. (1988) for a descriptions of the problems of a hybrid tax system.

productivity and income in the long-run. Problems arise when we look at transition and distributional issues. Some critics have argued that equity considerations and transition problems related to changes in asset prices blunt the case for a complete move to consumption taxation and make it politically less viable. In particular, the elimination of many middle-class tax deductions reduce middle-class support for tax reform. Possible adverse impacts on asset prices may make some individuals, particularly the elderly, worse off than under the current tax system. Any debate on tax reform will consider the trade-offs between the long-run benefits and the short-run transition problems.

This study examines the conceptual basis for a consumption tax and introduces many features, previously ignored in tax reform analyses, of a modern economy which substantially strengthen the case for switching completely to consumption taxation. Despite the theoretical literature, some authors (e.g., Gravelle, 1994) still assert that efficient taxation of capital depends on the relative elasticities of consumption demand and labor supply. We review the theoretical ideas behind the consumption tax and show that the case against capital taxation and for consumption taxation is surprisingly robust, not depending on unknowable, technical details of the economy. This conceptual foundation then leads us to explore other aspects of consumption versus capital taxation. In particular, we explore the implications of adding imperfect competition, risky assets, and human capital formation to the standard analysis. Any analysis, including that in this paper, must make many simplifications, and ignoring those elements was natural for initial analyses of tax reforms. Now that we understand the implications of tax reform in a competitive economy, we should extend our models and make them more realistic. It is natural to include imperfect competition, risky assets, and human capital in tax analysis since it is difficult to imagine a modern dynamic economy without these features.

Most will not be surprised that adding imperfect competition, risky assets, and human capital affects our results, but this study argues that incorporating these elements substantially strengthens the case for a consumption tax. First, including these elements of a modern economy substantially increases our estimates of the gains to long-run productivity. Interactions between taxation and imperfect competition increase the welfare cost of income taxation. The current U.S. tax system discriminates against risky assets; we show that any tax reform which eliminates this feature will produce significant efficiency gains. Including human capital in our analysis increases the welfare gains of eliminating taxation of income on new investment.

Second, these extra considerations also reduce transition problems. The

incorporation of imperfect competition reduces, possibly even reverses, adverse movements in asset prices. This change, plus a detailed view of U.S. demographics, reduce the problems of protecting older individuals who may not live long enough to enjoy the long-run benefits of tax reform. The incorporation of human capital also suggests new ways, consistent with the consumption tax principle, to compensate the middle class for the elimination of current deductions.

We motivate these considerations by reviewing some basic ideas from public economics and industrial organization. In particular, we present the inverse elasticity and production efficiency results from optimal tax theory, use them to analyze the inefficiencies of conventional income tax, and discuss interactions between taxation and imperfect competition. Conventional discussions focus on the distinction between income and consumption taxation. We argue that there is really no distinction between income and consumption taxation since income taxation is really a special pattern of consumption taxation. More precisely, we argue that income taxation is a particularly bad form of consumption taxation violating basic rules for a good tax system. This paper argues that the focus should instead be on the taxation of consumption today versus consumption tomorrow, and on the taxation of intermediate goods versus the taxation of final consumption goods. This focus helps explain old results and point in useful new directions.

First, there are many tax-like distortions in the private sector. When economics professors teach competitive economic theory they often use the example of the hundreds of thousands of farmers producing some agricultural product, and correctly argue that no individual producer has any impact over the price of his crop. This competitive paradigm is the one usually employed in tax reform analysis. While the competitive model may have been a valid simplification in 1798, it is certainly not in the modern industrial high-technology U.S. economy of 1998. Today imperfect competition and oligopolistic interactions provide a more appropriate description of much of the economy, and is particularly appropriate when discussing capital goods and innovations which are sources of economic growth. Some of the ideas of competitive theories still hold. In particular, competitive forces in oligopolistic sectors may reduce profits to competitive returns and prices to average cost. However, we expect prices to exceed marginal cost. Efficiency and welfare is determined by the relation between price and marginal cost, not price and average cost. This wedge between price and marginal cost is essentially a tax, even when it is generated by the private economy.

We show that the presence of imperfect competition strengthens the case for consumption taxation since it increases our estimates of the aggre-

gate efficiency gains of tax reform. In fact, we show that estimates of the discounted welfare gains from switching to a consumption tax are at least doubled for central estimates of the critical parameters, and the estimates of the long-run gains are even greater.

Second, risk is usually ignored in tax analysis. This is potentially an important problem since the current income tax discriminates against risky equity investment in favor of safe debt investments. This discrimination appears to violate optimal taxation principles: if both risky and safe assets produce income for future consumption, why should the tax system discriminate between alternative investment strategies? Consumption taxation would eliminate this discrimination, improving both the allocation of capital and incentives to save. Even some partial reforms would be of substantial value. We show that eliminating the debt-equity distinction in the tax code may by itself achieve half the benefits of moving completely to a consumption tax.

Third, tax analyses usually focus on labor supply and physical capital formation. Since human capital is more important than physical capital in a modern economy, this is a serious limitation. Many economists argue that the current tax and education system puts little tax burden on human capital formation, a position which would seem to justify the focus on physical capital taxation. We make two points. First, we show that adding human capital formation to our analysis increases the estimated benefits from tax reform even if human capital investment incentives are undistorted. Second, we argue against the conventional view, pointing to the large amount of educational expenditures, both private and public, which would be included in the tax base by most tax reform proposals. This fact violates the consumption tax principle since a true consumption tax would define the tax base to be output minus all investment expenditures.

These three considerations, imperfect competition, risk, and human capital accumulation, all indicate that consumption taxation is even more beneficial, both in the long run and along the transition, than conventionally argued. These points initially ignore distributional problems. Since distributional concerns are important to any political advocacy, we make two important points. First, some distributional analyses argue that the elderly may lose from tax reform. A switch to consumption taxation may cause them to pay new taxes, either directly or implicitly through a decline in asset values, on their wealth. In particular, Gravelle (1995) predicts a 20-30% fall in stock prices if the Hall-Rabushka Flat Tax is passed. These arguments typically assume perfect competition where no firms earn any economic rents. While farms and other small businesses may be competi-

tive, they are not part of anybody's stock portfolio. It is difficult to view firms like Microsoft, GM, and Boeing as perfectly competitive price takers. I also suspect that their CEO's would not last long in their jobs if they were satisfied with normal profits and did not pursue opportunities to earn extranormal profits for their shareholders. We argue that any predictions of asset price collapses are blunted, possibly even reversed, when we include imperfect competition in the analysis. The presence of imperfect competition implies that firms earn pure profits on extra production, and that the increase in future output induced by the Flat Tax (or any other consumption tax) would cause asset prices to immediately rise. This asset price increase would allow elderly asset holders to participate now in the future benefits of tax reform, and make tax reform more uniformly beneficial across the generations.

Second, many middle class families would lose from tax reform. Two reasons for this are the loss of deductions for home mortgage interest and state and local taxes. Some propose keeping the mortgage interest deduction to avoid middle class losses and get them to join the political coalition for a consumption tax. This would substantially reduce the potential efficiency gains of tax reform since it would continue the current bias against nonresidential business investment. An alternative adjustment in tax reform proposals is to allow the deductibility of some educational expenditures. This would help with the distributional issues since such deductions could be aimed at middle class taxpayers, but would not deviate from the consumption tax principle.

Many consumption proposals have been put forward, including those described in Bradford (1986), Hall and Rabushka (1995), McLure and Zodrow (1996), and Weidenbaum (1997). These ideas also apply to any VAT or national sales tax proposal, since they would eliminate taxation of income on new investment. I do not focus on any one proposal since the arguments for consumption taxation made here apply to all of them. Other proposals argue for eliminating the double taxation of equity income through the integration of individual and corporate taxation, thereby eliminating the asymmetric treatment of equity and debt assets; see U.S. Treasury (1992). Many of our results also apply to those proposals since we will be focusing on capital income taxation. Similarly, our arguments apply to more conventional tinkering of the tax code such as the reintroduction of the investment tax credit. Our results show how important it is to include imperfect competition, risk, and human capital formation to the analysis of any tax reform proposal.

The case for consumption taxation is strong, and made stronger when

we include those features which make our economy a modern and technologically advanced one. Recognition of these elements should help us achieve substantive tax reform.

1 Evaluating Alternative Tax Systems

This section presents the conceptual foundation for our arguments. Any tax system will produce distortions and damage economic performance. The task of policymakers is to choose a tax policy which produces the least damaging pattern of distortions. This task is particularly difficult in a dynamic economy where one needs to trade off distortions today against their future consequences.

The arguments in this paper rely on two basic results from optimal tax theory plus an argument from monopolistic competition theory. First, the inverse elasticity rule[3] argues that the tax on a good should be inversely proportional to its demand and supply elasticities. We show how to apply that rule to dynamic contexts, and why an income tax is really a particularly inefficient kind of consumption tax.

Second, the productive efficiency principle of Diamond and Mirrlees argues against the taxation of intermediate goods, such as capital. The current tax system discriminates in favor of capital in the form of owner-occupied housing and against capital used to produce other goods. It also treats human capital and physical capital differently even though both are essentially intermediate goods. Financial structure is also a type of intermediate good since debt and equity have no direct consumption value, but the current U.S. tax system discriminates against equity and in favor of debt. The productive efficiency principle helps us understand what a true consumption tax would look like and why deviations from the productive efficiency principle are so damaging to economic efficiency.

Third, we display similarities between taxation and imperfect competition. Any firm which has some control over the price it charges for its goods will charge a price in excess of marginal cost. That gap is similar to a tax. Recognizing the presence of imperfect competition is similar to recognizing the presence of other taxing authorities. The presence of these other "taxes" will significantly affect our view of the government's taxes.

[3]See Atkinson and Stiglitz (1972) and Atkinson and Sandmo (1980) for formal presentations of optimal taxation theory.

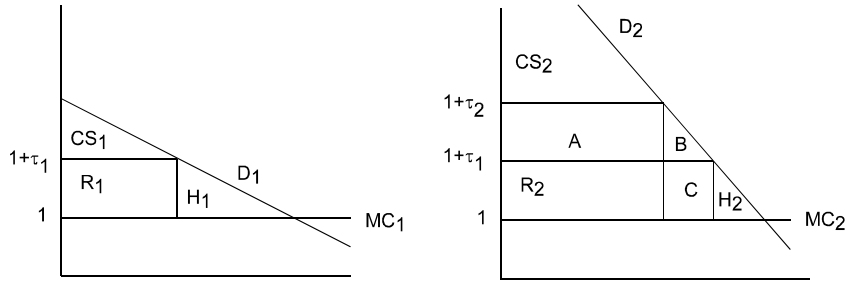

Figure 1: Inverse Elasticity Rule

1.1 The Inverse Elasticity Rule and Asset Income Taxation

The inverse elasticity rule says that the optimal tax on a commodity is inversely proportional to its demand elasticity[4]. We can illustrate this by considering the demand curves for two goods displayed in Figures 1. Both goods are assumed to have a constant unit marginal cost. The demand curve for good 1 in the left half of Figure 1 displays the impact of a tax equal to τ_1. The box R_1 is the revenue raised by the tax, CS_1 the consumer surplus, and H_1 the efficiency cost of the tax. Demand for good 2, displayed in the right half of Figure 1, is assumed to have be less elastic. If we imposed the same tax rate of τ_1 on good 2 the revenue is R_2 and the welfare cost is H_2. Since the demand for good 2 is less elastic, the optimal policy is to tax good 2 at a higher rate, say τ_2. This higher tax increases revenue by an amount equal to the area in box A minus the area in box C. The extra efficiency cost is $B + C$. The objective is to equate the marginal cost of a higher tax per dollar of revenue across different goods. This is accomplished by imposing higher taxes on the less elastically demanded goods. In Figure 1 we would set the tax on good 1 at τ_1 and choose a higher tax of τ_2 on good 2.

The inverse elasticity rule may seem to have little application to discussions of income taxation and savings. However, it is the best way to view income taxation. Suppose that the different goods in Figure 1 represent consumption of goods and leisure at different dates. Income taxation implies a pattern of distortions across consumption and leisure at various dates. For example, if we save some money at time 0 for consumption at time t, then a tax on investment income essentially taxes consumption at time t. Suppose r is the before-tax interest rate, and τ is the interest tax

[4]We ignore supply elasticities in this discussion since they are not as relevant for our applications of the inverse elasticity idea.

rate. The social cost of one unit of consumption at time t in units of the time 0 good is $(1+r)^{-t}$ and the after-tax price is $(1+(1-\tau)r)^{-t}$. This implies a tax distortion between MRS, the marginal rate of substitution between time t consumption and time 0 consumption, and MRT, the corresponding marginal rate of transformation, equal to

$$\frac{MRS}{MRT} = \left(\frac{1+r}{1+(1-\tau)r}\right)^t \tag{1}$$

This distortion is the same as if we taxed consumption at time t at the rate

$$\tau_c^* = \left(\frac{1+r}{1+(1-\tau)r}\right)^t - 1 \tag{2}$$

The key fact illustrated by this formula is that the commodity tax equivalent is exploding exponentially in time!

The situation is displayed in Figure 2. Figure 2 shows the demand for the time t consumption good relative to some untaxed good c_0 (such as time 0 leisure). This income tax is equivalent to a commodity tax on time t consumption equal to τ_c^* per unit of the time t good. We make the common assumption that the consumption demand curves are identical and independent across time and not affected by leisure. The optimal tax system would impose the same tax on consumption at each different time. Instead, a constant positive interest tax is equivalent to an exponentially growing tax on time t consumption, strongly violating the inverse elasticity rule. Notice in Figure 2 that as t increases, the deadweight loss triangle, H, grows and squeezes the revenue box, R.

The exponential explosion in (2) appears dramatic, but we need to check that it is quantitatively important over reasonable horizon. Table 1 displays the consumption tax equivalents, τ_c^*, for various combinations of r and τ. We see that the results depend substantially on the magnitude of r. For $r = .01$, the mean real return on safe assets, the effects are small. For example, even a 50% tax on interest income implies only a 22% tax on consumption tax 40 years hence compared to a .1% tax on consumption a year away. However, the situation is much different when $r = .10$. When $\tau = .3$ (which is less than the tax rate on equity-financed capital), the effective consumption tax over a one-year horizon is 3%, but it is 59% over a ten-year horizon, and a whopping 543% over a 40-year horizon! It is hard to imagine any government passing a 59% sales tax in 2008, but that is effectively what we do to many investors if we continue with an income tax system between 1998 and 2008.

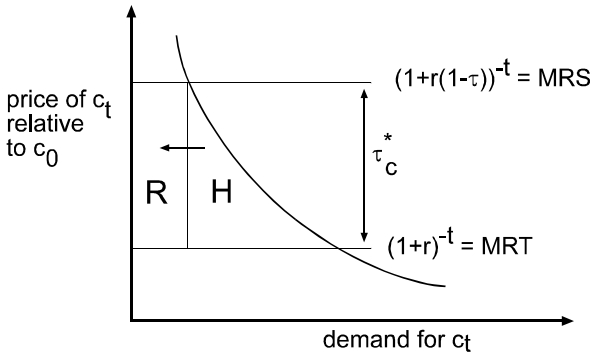

Figure 2: Commodity Tax Equivalents of Asset Income Taxation

Table 1: Consumption Tax Equivalents, τ_c^*

r	τ	t					
		1	5	10	20	30	40
.01	10	.1	.5	1	2	3	4
	30	.3	1	3	6	9	13
	50	.5	2	5	20	16	22
.10	10	1	5	10	20	31	44
	30	3	15	32	74	129	202
	50	5	26	59	154	304	543

The implications of this analysis are clear. If utility is separable across time and between consumption and leisure, and the elasticity of demand for consumption does not change over time, the best tax system would have a constant commodity tax equivalent. This can be accomplished by a constant consumption tax. However, any nonzero asset income tax produces substantial violations.

While the exposition above focuses on special cases, the result is robust. The results in Judd (1985b, 1999) show that the optimal tax on asset income is zero in the long-run, even when preferences are far more general than those used in dynamic tax analyses. The key idea is that exploding consumption tax rates are not efficient and that the explosion is quantitatively important.

This result is not just an aggregate result assuming everyone is the same. It is true for each individual if his tastes do not change significantly over time. Therefore, even if tastes vary across individuals, each individual will

prefer a constant consumption tax over an income tax which extracts the same revenue from him.

The inverse elasticity rule argues for a different tax on all goods, whereas consumption tax proposals actually propose a single tax rate. While this may appear to be a serious difficulty, we will ignore it. This approach is supported by the arguments in Balcer et al.(1983). They show that while an optimal commodity tax system would have very different rates across goods, there is little welfare difference between that tax system and a revenue-equivalent flat tax. Given the extra complexity and administrative cost of a tax system which charges different tax rates on different goods, it seems sensible to stay with a uniform consumption tax.

This analysis does not necessarily imply that there should be no taxation of asset income. Suppose that tastes depend on age. If we assume that the elasticity of demand for consumption fell with age in just the right way, then a constant interest rate tax would be optimal; this would require the demand curve in Figure 2 for the time t good to become less elastic as t increases. Such an age-dependence could result if one had just the right interaction between consumption demand and leisure. However, I have not seen advocates of asset income taxation use this approach[5]. My suspicion is that these arguments would be very fragile since our knowledge of the critical elasticities is too imprecise for such a purpose. In any case, it is hard to imagine demand elasticities changing enough to justify substantial asset income taxation. In particular, Table 1 tells us that to justify a 30% income tax if $r = .1$ over a twenty year horizon, we would need consumption elasticity to fall by a factor of 25 over those 20 years, a rather implausible situation. Therefore, the constant elasticity case is a reasonable one to use.

The distinction between factor income taxation and commodity taxation is misleading since none of the problems in Figure 2 applies to wage income taxation. If τ_L is a constant wage tax and τ_K a constant interest rate tax, the MRS/MRT distortion between time 0 consumption and time t leisure is

$$\left(\frac{MRS}{MRT}\right)_{c_0,\ell_t} = \left(\frac{1}{1-\tau_L}\right)\left(\frac{1+r}{1+(1-\tau_K)r}\right)^t \tag{3}$$

Equation (3) represents how taxes distort decisions to sacrifice consumption at time 0 to gain extra leisure at time t. This distortion also grows over time but only because of the interest rate tax. Wage taxation does not

[5]Simulations of tax policy analysis may stumble on this if they assume tastes which lead to time-varying consumption demand elasticities.

aggravate the distortions in savings but asset income taxation does aggravate distortions between consumption and leisure at different dates.

Our commodity tax interpretation of factor income taxation and the inverse elasticity rule reveal many features of factor taxation. This approach shows us how distortionary asset income taxation is, and hints at the value of removing it from tax systems.

1.2 The Productive Efficiency Principle

The second important principle is the Diamond-Mirrlees result about productive efficiency. The essential argument is that a tax system may unavoidably cause distortions in consumption, but there is no need to also force the economy to produce that output in an inefficient fashion. The chief implication of the Diamond-Mirrlees efficiency result is that an optimal tax system would tax only final goods, not intermediate goods.

For example, we may want to tax clothing and meat, but we do not want to tax sewing machines and meat storage lockers. If we taxed sewing machines, clothing producers would substitute away from mechanical production and towards labor-intensive methods, reducing the productivity of the economy. Even if we wanted to tax clothing more heavily than meat, any differential treatment of sewing machines and meat storage lockers would just distort the allocation of capital. Taxes on sewing machines and meat lockers are all ultimately paid by consumers in any case. It is better to rely on direct taxation of clothing and meat consumption and allow the production of both to proceed undistorted by taxation of capital inputs.

The productive efficiency principle applies to any analysis of income taxation since capital goods are intermediate goods. In fact, taxation of capital goods is equivalent to sales taxation of intermediate goods. This can be seen by noting, for example, that a 100% sales tax on capital equipment is equivalent to a 50% tax on the income flow from that capital equipment. Since intermediate good taxation will generally reduce the productivity of an economy, capital income taxation will likely produce similar factor distortions, particularly if there are many capital goods.

When we combine the productive efficiency principle with the inverse elasticity principle, we arrive at a strong case against capital income taxation. Differential taxation of capital goods will produce inefficiencies in the allocation of productive inputs. A uniform tax on capital inputs may not distort allocation but will effectively create an exploding consumption tax as illustrated in Table 1. Therefore, an optimal tax structure would tax only final goods.

The productive efficiency principle is well-recognized in tax reform arguments. One of the key benefits from consumption taxation is the elimination of differential taxation across various capital goods; see Auerbach (1989) and Goulder and Thalmann (1993) for recent examinations of the importance of productive efficiency. The changes in 1986 attempted to create uniform taxation across capital goods. Auerbach (1989) argues that any optimal deviations are small under perfect competition.

The Diamond-Mirrlees principle does rely on special assumptions, leading some to argue against its relevance in tax discussions. Two provisos immediately come to mind. First, Diamond and Mirrlees assume each commodity is taxed at a separate rate. Again, as we indicated above, we do not view that as a serious problem. While Balcer et al. (1983) did not consider a general equilibrium case where intermediate goods could be taxed, we suspect that their conclusion that uniform taxation is almost as good as the optimal nonuniform tax is robust. Second, the productive efficiency result also assumes that all pure profits are taxed away, whereas pure profits are not taxed away in the current tax system nor in any proposed reform. In fact, the drop in marginal rates from most reforms would reduce the taxation of pure rents. We will show that this is also not a serious impediment to applying the production efficiency principle when we consider plausible estimates for tastes and technology.

This Diamond-Mirrlees productive efficiency principle provides us with a theoretical basis for consumption taxation. However, it also tells us that we need to pay careful attention to what is an intermediate good and what is a final good. This distinction will play a critical role below in our discussion of human capital.

1.3 Imperfect Competition and Taxation

The third idea we use is that taxation decisions of the government and the distortions produced by imperfect competition in the private sector are similar in their implications. A firm which charges a price above marginal cost is effectively acting as a tax collector. Any national consumption or income tax is imposed on top of any private sector distortions. This accumulation of distortions will substantially affect our estimates of the burden of taxes and our relative evaluation of consumption and income tax systems.

The key principles are displayed in Figure 3. Suppose that a good is not sold at its marginal cost, equal to 1 in Figure 3, but is sold at a marked up price, $1 + m$. This markup can arise and be sustained for many reasons. The producer may have market power because of large fixed costs of entry

or because his product is differentiated from the products of competitors. Alternatively, the producer may hold a patent which makes him a legal monopolist.

Any markup above marginal cost acts essentially as a tax. In Figure 3, H_m, is the efficiency cost of such a markup, just as H_1 and H_2 were the efficiency costs of taxation in Figure 1. The box $P + H_{\tau m}$ in Figure 3 is the monopolists "tax revenue" constituting profits in excess of economic costs. The economic effects of any markup is similar to taxation since both cause the buyer to pay a price in excess of the true marginal cost. These two cases differ in who receives the markup, the government in the case of a tax and a private firm in the case of a markup. Both taxation and markups creates efficiency losses and rents.

We will rely heavily on this analogy between taxation by the government and markups arising from imperfect competition. This analogy is particularly appropriate in the case of patents. The holder of a patent is not necessarily a monopoly producer. In fact, many patent holders do not produce their product. The key feature of a patent is that the patent holder can impose a tax on the purchase of the patented good, either directly through producing the good and charging a price in excess of marginal cost, or indirectly through a royalty. These distortions reduce economic efficiency and lead to underproduction of the patented good, but are justified by the incentives they create for innovation. Without the rents produced by a patent, an innovator may not have sufficient incentive to undertake the fixed costs of research and development, a situation leading to an even worse situation of no production of a desirable product. Therefore, even though patent monopolies reduce efficiency just like taxes do, we do not want to destroy the rents they create.

The patent monopoly story is the simplest one we can use to illustrate the key arguments, but our points are more robust and apply to any context where firms charge a price in excess of marginal cost. In many cases these markups occur due to product differentiation and increasing returns to scale, situations which share many features of a patent monopoly even if there is no formal property right. Our analysis revolves around the presence of a markup of price over marginal cost,.whether it arises from patent monopoly, an oligopoly of differentiated competitors, or some other form of imperfect competition.

Markups may also occur due to collusion or corruption, but that is the concern and responsibility of antitrust policy. Our arguments apply to imperfect competition which remains after appropriate application of antitrust laws. We do not argue that tax policy is a substitute for antitrust policy. In-

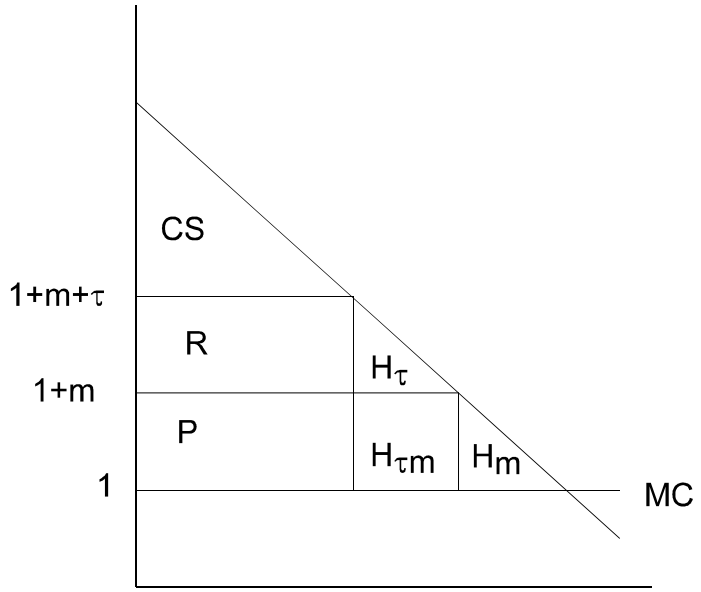

Figure 3: Taxation and Monopolistic Competition

stead, we argue that tax policy should take notice of the fact that imperfect competition is an important part of any modern economy.

Suppose that we introduce a tax τ into an imperfectly competitive market. The buyer now pays both the markup and the tax, resulting in a total price of $1 + m + \tau$. The $m + \tau$ portion acts as a tax, raising price above the marginal cost and producing revenues now for the government. In this case, the government's revenue is the box R and the firm's profits are P. The tax τ causes the monopolist to lose the box $H_{\tau m}$ in profits and causes the consumers to lose H_τ in consumer surplus. The cost of the tax is not just a triangle of consumer surplus but also a box of pure profits. The efficiency cost of the tax is now larger relative to the revenue raised because of the pre-existing distortion.

Joan Robinson (1934) noticed these facts and argued that a good tax policy would use subsidies to bring buyer price down to social marginal cost. This would imply that in Figure 3 we would want to pay the buyer a subsidy equal to the markup m. She also argued that this policy would have some undesirable effects since it would increase monopoly profits and likely be regressive in its impact on income distribution. Since it would be difficult to tax away these extra profits, she did not endorse such an approach.

We argue that these distributional concerns are not important in the U.S. economy. In modern dynamic economies, it is difficult for a firm to maintain large monopoly rents. High profits encourage entry by imitators. We used to think of IBM as a firm with large market power before it was hit by competition from competing producers of personal computers and workstations. For many firms, the current profits arising from setting prices above marginal costs are necessary to recover R&D costs and other fixed costs of production. This view of monopolistic competition is supported by Hall(1986) who finds that there is little evidence of supernormal returns to firms even though he finds that prices substantially exceed marginal costs.

Before continuing, we should note the limited way in which we will use these imperfect competition ideas. The key idea here is that pre-existing distortions increase the efficiency cost of governmental taxation, even if tax policy is not used to fine-tune those distortions. We will see below how this limited argument strengthens the case for consumption taxation.

1.4 Taxation in a Simple Dynamic Competitive Model

We will use some standard analysis to illustrate the significant benefits of moving away from asset income taxation and towards consumption taxation. We assume the simple growth model used in Judd (1987). The key features in Judd(1987) are that output is produced by capital and labor, and is divided into consumption and investment. There are no adjustment costs, and we use the representative agent paradigm. We assume a Cobb-Douglas production function with capital share .25. We assume that labor supply has a compensated elasticity equal to $\eta > 0$ and that the consumption demand elasticity[6] is $\gamma > 0$. We assume a proportional tax on labor income at a rate of τ_L and a proportional tax on capital income at rate τ_K .

Table 2 displays the marginal efficiency cost of various tax changes for various values of γ and η. We assume that the economy begins with one tax policy and makes small changes in labor or capital income taxation, or introduces a small investment tax credit (ITC) applied to all investment. We do not explicitly include a consumption tax, but an increase in an ITC has the same effect of reducing the effective tax on new capital without reducing the taxation of old capital. For example, the Flat Tax proposes expensing of capital expenditures, a measure which is equivalent to a large ITC. These three policy tools cover most of the policy options used in the past and proposed for the future.

[6]See Judd, 1987, for a long list of empirically estimated labor supply elasticities and labor tax rates used there to compute MEB.

We first examine the case where $\tau_L = \tau_K = .3$ initially, and then we examine the case where the economy begins with $\tau_L = .4$ and $\tau_K = .5$. MEB_L is the marginal loss of utility (measured in dollars) per dollar of revenue raised if τ_L is increased. MEB_K (MEB_{ITC}) is the corresponding index for increases in τ_K (an ITC). The MEB indices in Table 2 are discounted present values which include the transition process from one tax policy regime to another. We expect the $MEB > 0$ since we expect that any tax policy change which raises revenues will reduce utility; however, $MEB < 0$ is possible in severely distorted systems.

Table 2: Efficiency Costs of Various Policy Changes

		$\tau_L = .3,\ \tau_K = .3$			$\tau_L = .4,\ \tau_K = .5$		
γ	η	MEB_L	MEB_K	MEB_{ITC}	MEB_L	MEB_K	MEB_{ITC}
.1	.1	.02	.15	.46	.04	.38	1.1
.1	.4	.04	.21	.72	.07	.51	1.8
.1	1.0	.05	.25	.99	.08	.62	2.5
.5	.1	.04	.36	1.9	.07	1.3	−15.
.5	.4	.11	.42	2.6	.21	1.5	−9.8
.5	1.0	.19	.48	4.0	.35	1.7	−7.3
2.0	.1	.05	.69	−240.	.09	5.8	−2.8
2.0	.4	.20	.91	−6.9	.39	22.	−2.4
2.0	1.0	.50	1.3	−3.5	1.19	−11.	−2.0

Table 2 illustrates several important points. First, we do not have a good quantitative grasp of the welfare costs of tax changes. The values of critical parameters used in Table 2 are all in the range of existing empirical estimates. It is difficult to choose among the empirical estimates of γ and η since they differ in terms of data sets and estimation strategy. The typical calibration approach would argue vigorously for one particular parameter choice and ignore others. I am sceptical about our ability to make such choices given the noisy data we have and the enormous gap between this simple model and the far more complex real world.

Second, Table 2 shows us that we do not need good estimates to rank alternative tax policy changes. In all cases in Table 2, replacing capital income taxation with labor income taxation would improve welfare, usually by a substantial amount relative to the revenue shift. Furthermore, changes which focus on encouraging new investment, such as the ITC, are particularly effective in improving economic performance with small revenue loss. In fact MEB_{ITC} is sometimes negative, implying that an increase in the

ITC would raise revenues because the extra capital income tax revenue on the new capital and the extra wage taxation from the higher wages would pay for the costs of the investment tax credit. An increase in the ITC is similar to the introduction of a Flat Tax. Both reduce taxation of new investment but do not reduce the tax burden on old capital. In fact, the Flat Tax can be viewed as an income tax at rate τ and plus an ITC at rate τ and no depreciation allowances.

Third, the more elastic the labor supply, the greater the difference between MEB_L and MEB_K. A static perspective suggests that the relative costs of labor and capital income taxation depends on the elasticities of savings and labor supply, and that as the labor supply elasticity increased, the welfare cost of labor taxation relative to capital income taxation would rise. The opposite is true in Table 2 where both MEB_K and MEB_{ITC} rise even more rapidly than MEB_L as we increase labor supply elasticity, η. The resolution of this puzzle lies in our MRS/MRT distortion expressions above in (1) and (3). These expressions tell us that asset income taxation implies an exploding distortion for both consumption and leisure demand. As the labor supply elasticity rises, the importance of this labor market distortion also rises, and the total distortion due to asset income taxation rises.

The $\tau_L = \tau_K = .3$ case for the initial tax policy is low relative to the current U.S. tax system. The case of $\tau_L = .4$ and $\tau_K = .5$ is closer to the conventional description of the tax system before 1981, but is not generally considered descriptive of the current tax system. Of course, the welfare benefits of tax reduction is much greater when we begin with higher tax rates. We will also see that the $\tau_L = .4$ and $\tau_K = .5$ scenario is actually plausible when we consider the impact of imperfect competition.

The robustness of the results in Table 2 is surprising since we normally expect the results from computational general equilibrium to depend critically on the elasticity parameters. The magnitudes of the MEB indices do depend on elasticity values, but the ranking of alternative policies does not. This indicates that something fundamental is behind the results. We argue that the critical facts come from optimal tax theory: taxation of asset income corresponds to exploding commodity taxation but labor taxation and consumption taxation do not.

1.5 Optimal Tax Theory and Tax Reform

Before continuing, we will summarize our theoretical arguments. It is important to do this since our results strongly contradict the standard intuition used by many in the tax reform literature.

Gravelle's (1994) discussion of the welfare effects of consumption versus capital income taxation is a good statement of the commonsense approach. She asserts[7]

> Theory does not tell us, a priori, whether eliminating capital income taxes will increase overall efficiency, since it reduces one distortion at the price of increasing another. ... The efficiency effects depend on assumptions about behavioral effects. If individuals are relatively unwilling to substitute consumption over time and relatively willing to substitute leisure for consumption of goods, then a significant tax on capital income would constitute part of an optimal tax system. These behavioral effects are difficult to estimate empirically.

This intuition is a natural one. Its references to substitution propensities appear to invoke the inverse elasticity rule we also invoke, and argues that we must accept trade-offs among various distortions. However, the arguments we have made do not make any qualifications concerning the relative elasticity of intertemporal substitution and labor supply. Separability assumptions were made in some earlier analyses, but even those assumptions are absent in Judd (1985b). Many of the analyses arguing for no long-run taxation of capital assume a constant intertemporal elasticity of consumption, but that focus is not restrictive. Table 1 shows that even a small capital income tax implies rapidly exploding consumption tax equivalents, and there is no evidence that individual consumption elasticities vary enough to make such a tax policy efficient. Plausible values for consumption demand and labor supply elasticities offer no support for asset income taxation in the long run.

This discussion ignores the transition process, but there again we find no evidence supporting asset income taxation on efficiency grounds. Table 2 in fact shows the opposite. The gaps $MEB_{ITC} - MEB_L$ and $MEB_K - MEB_L$ represent the efficiency gain from increasing labor taxation and using the revenues to finance an increase in the ITC or a decrease in capital income taxation. Table 2 shows that this gain increases as we increase our estimate of the elasticity of labor supply. As the elasticity of labor supply increases, it is more valuable to increase *labor* income taxation and reduce *capital* income taxation, even when we consider the transition process.

The theoretical case against capital income taxation in favor of consumption taxation is much stronger than conventionally thought. There are qualifiers, of course. For example, Hubbard and Judd (1986, 1988) show

[7]See Gravelle (1994), page 31.

that asset income taxation may be desirable when capital markets are imperfect. The intuition there is straightforward: capital income taxation may be useful if it is a substitute for missing capital markets. However, these findings are sensitive to the nature of market incompleteness. It is unclear if those considerations can justify observed capital income tax rates. For example, it is difficult to imagine that liquidity constraints could justify the corporate income tax. It is also possible that capital market failures can be better resolved through more modest adjustments of a consumption tax.

We have so far considered the choice between consumption and income taxation in the simplest possible model: perfect capital markets, perfect competition, no risk, and only physical capital and raw labor inputs. We now deviate from this simple model and show that the case for consumption taxation is strengthened.

2 Imperfect Competition and the Benefits of Consumption Taxation

Tax reform analyses usually assume perfect competition in all markets. This is not a good description of a modern economy. While no one would disagree with this assertion, it is not immediately clear how this affects tax policy evaluation. We argue that the presence of imperfect competition strengthens the case for consumption taxation.

The basic idea we pursue here is a combination of two well-known ideas. First, we use the Robinson argument that subsidies can be used to offset the distortions if a lump-sum tax is available. At first that seems to be of limited usefulness since it would imply that most goods would be subsidized, leaving one to wonder what is left to tax to finance these subsidies as well as normal expenditures. Second, Diamond and Mirrlees (1971) tell us that only final goods should be taxed, not intermediate goods. Since markups are similar to taxation, this indicates that the final *net* tax on intermediate goods should be zero, no matter what the impact on final good taxation. In combination, these principles indicate that final goods should be taxed to finance corrective subsidies of any intermediate good, including capital goods, which is sold at a price above marginal cost.

We use this controversial assertion in a very limited way. The pure theoretical argument ignores many practical difficulties. It would be impractical to construct the perfect corrective policy, and we do not advocate any attempt to do so. We make much more limited use of this argument. We emphasize that if it would be optimal to reduce price-cost margins for in-

termediate goods, then it is surely not a good idea to impose taxes which aggravate price-cost margins for intermediate goods. In a competitive world, a small tax on intermediate goods may cause only small damage to the economy's efficiency. In a world with imperfect competition in intermediate goods industries, even a small tax on intermediate goods could cause substantial damage.

Since asset income taxes are equivalent to intermediate good taxes, this shows that small asset income taxes can create large efficiency losses. This observation strengthens the case for switching away from tax systems, such as conventional income taxation, which aggravate the distortions of imperfect competition, and towards consumption tax policies.

2.1 Financing Social Fixed Costs and Taxation

Our results will first appear strange and in conflict with the principles of free market economics. Before we give a more concrete analysis, we present a simple example of fixed costs in production where we apply the Diamond-Mirrlees model, and compare its prescriptions to how we actually finance fixed costs.

Suppose that there is one capital good, call it computers, which has constant unit cost after some large fixed cost is paid for, say, R&D. This good cannot be produced in a perfectly competitive market since a price equal to marginal cost will not allow the firm to recover the initial fixed costs. There must be some deviation from competitive pricing to finance this fixed cost. Diamond-Mirrlees says that the optimal way to finance the fixed cost for computers is to tax final goods only. The pattern of final good taxation is governed by the inverse elasticity rule, not by which goods use computers in their manufacture.

Compare this to the manner we actually finance fixed costs, such as R&D expenditures. The computer manufacturer needs to limit competition so that it can charge a markup over marginal cost sufficient to finance the fixed cost. The economies of scale may be sufficient to deter entry, or perhaps the computer manufacturer can get a patent on computers. The manner in which market power is attained is not particularly important, but some form of market power is necessary.

It has long been recognized that we need to deviate from perfect competition if we are to create the proper incentives for innovation. The U.S. Constitution specifically recognizes the need "to promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries." Patents and

copyrights create market power but are valuable instruments to encourage innovation. Since innovation is considered an important policy concern of government, it is natural for tax policy be designed so to avoid any interference with innovation policy.

The analysis in this paper has avoided any explicit modeling of innovation. Innovation in a dynamic world has been modeled in many ways; see Judd (1985a) for an example, and Barro and Sala-i-Martin (1995) for a review of the literature. For the sake of simplicity, this paper assumes that there is no impact of tax policy on innovation. If we included endogenous innovation, then moving to a consumption tax would increase innovation in capital goods and further increase our estimates of the gains to consumption tax reform. The differences would be sensitive to details which are difficult to estimate. In this paper we take a more conservative approach where we focus solely on the distortions of imperfect competition and the price-cost margins which are easier to estimate.

The incidence of market power in a patent or similar system of protection for intellectual property will likely be very different from the incidence of the distortions in the ideal Diamond-Mirrlees scheme. Only computer users pay the markup in computers. Computer users will substitute away from computers and towards alternative intermediate goods. The markup in computer prices will most affect those final goods which use computers in their production. This will result in an inefficient pattern of distortions across final goods since those computer-intensive products may not be the ones which would be taxed in an optimal Diamond-Mirrlees scheme. It may be impossible to attain the perfect Diamond-Mirrlees set of distortions, but this fact only strengthens our case since the excessive burden imposed by imperfect competition on intermediate goods would only be further aggravated by any taxation of capital income.

Economic growth requires the creation of some incentives for innovation. The patent and copyright systems succeed in this but they create distortions in the private sectors. Therefore, tax policy in a modern economy operates in a world already distorted by other "taxes." We will see that this insight has important consequences for the value of consumption taxation.

2.2 Empirical Evidence on Imperfect Competition

We next examine the evidence that there is significant imperfect competition. There have been many studies of the gap between prices and marginal costs. Furthermore, the empirical Industrial Organization literature contains some industry-specific studies on price-cost margins. These studies

also produce estimates for price-cost margins in the 20% range for some capital goods (see, e.g., Appelbaum, 1982). Both Hall (1986) and Domowitz et al. (1988) indicate that the margins in the equipment sectors are substantial in size, lying generally between 15% and 40% of the price. There is little reason to doubt the presence of significant economies of scale and significant deviations of price over marginal cost. Even a lower estimate of 10% is sizable when we remember that it is equivalent to a 10% sales tax on such equipment.

Fortunately, our discussion here does not rely critically on these estimates of price–cost margins, particularly for investment goods. In particular, R&D expenditures equalled 9.2% of sales for machinery and 4.7% for electrical equipment in 1990. Learning curves also produce increasing returns to scale which act essentially as a fixed initial cost. These considerations plus a conservative estimate of economies of scale and other long–run fixed costs puts us in a range relevant for our policy discussions. Therefore, even under conservative readings of the empirical evidence, the importance of imperfect competition appears substantial.

2.3 A Simple Model of Imperfect Competition

Judd (1995) examines a simple dynamic model which formally establishes our argument. It makes a few key assumptions. First, there is a fixed number of goods, all of which are produced in a monopolistically competitive market. Since the number of goods is fixed, marginal increases in demand results in pure profits for all firms. Each good can be used for both consumption and investment, and each of these goods is used in the production of all goods. Judd (1995) uses a representative agent model with elastic labor supply.

We assume that pure profits are taxed at the rate τ_Π and that income on marginal physical investment is taxed at rate τ_D. One interpretation is that the equityholders of each firm owns a patent on its good and uses debt to finance any physical investment. In equilibrium, the return on equity is the pure rent associated with holding the patent, and debtholders receive the marginal product of the physical investment. Therefore, dividend income is subject to corporate level and individual taxation, but the debt-financed physical capital income is taxed only at the personal level.

2.3.1 The Cost of Capital with Imperfect Competition in Capital Goods Markets

We next illustrate how the social cost of capital is altered by a combination of income taxation and imperfect competition. The cost of capital is determined by the usual arbitrage condition. Suppose that a firm is contemplating buying one more unit of capital with a social marginal cost of production equal to 1. Because of the markup m by the producer of the capital good, the investing firm pays $1 + m$ for the unit of capital. Suppose that the marginal product of capital is MPK. Assume that the firm's bondholders pay a tax τ_D on the earnings from this investment and receive an after-tax return of $\overline{r}$ on alternative investments. Investment will continue until the after-tax return (we assume no depreciation) from a one unit investment, $MPK(1 - \tau_D)$, equals the opportunity cost of the investment, $\overline{r}(1 + m)$. In equilibrium, the level of investment is determined by

$$MPK = \overline{r}\frac{1+m}{1-\tau_D} \tag{4}$$

If $m = 0$, (4) is the usual cost of capital formula. In the presence of monopolistic competition, the upstream markup of m on the purchase of capital goods acts in the same way as the downstream taxation of interest income.

To illustrate the combined effects of taxation and imperfect competition, we derive an effective combined tax rate. The situation in (4) is as if there were no markup and the tax on interest income were equal to τ^* where

$$\tau^* = 1 - \frac{1-\tau_D}{1+m} = \tau_D + \frac{m}{1+m}(1-\tau_D) \tag{5}$$

Table 3 presents values for the total effective tax rate τ^* for various values of the explicit tax τ_D and the margin m. For small tax rates and margins, the total effective tax rate is the sum $\tau_D + m$. At larger rates, τ^* is less than $\tau_D + m$, but presence of the margin m still substantially increases the total distortion. For example, the presence of a 30% margin causes the total tax rate to be 38% if $\tau_D = .20$.

Table 3: Effective Total Tax Rates

τ_D :	.1	.2	.3	.5
m :				
.05	.14	.24	.33	.52
.10	.18	.27	.36	.54
.20	.25	.33	.42	.58
.30	.31	.38	.46	.62

With the concept of effective total tax in (5), we can see how our earlier arguments apply. First, since markups on capital goods distorts investment just as an interest tax would, they produce the same kind of exploding distortion in (2) which occurs under an interest tax. A uniform markup on capital goods violates the inverse elasticity principle just as a constant asset income tax does.

Second, incorporating imperfect competition into our analysis forces us to reconsider the level playing field arguments. The conventional wisdom, based on perfect competition assumptions, is that the 1986 tax changes eliminated most of the differential taxation of capital goods; Auerbach (1989) is an example of such a study. Even if the explicit income taxes do not discriminate among alternative capital goods, the total effective tax rate τ^* will vary across goods to the extent that their margins vary. Studies such as Hall and Domowitz et al. both indicate substantial variance in margins among capital goods. Since the welfare costs of taxation are increasing in the variance of inappropriate distortions, our neglect of heterogeneous markups make our results conservative estimates of the inefficiency associated with capital income taxation.

2.3.2 Optimal Tax Policy

We next illustrate what the presence of imperfect competition implies for optimal tax policy. We assume in this exercise that one can determine the markups and use them for policy purposes. This is not a realistic assumption since it is difficult to measure markups with great precision. The purpose of this exercise is to illustrate how much the presence of markups could affect the optimal policy. The results will give us a strong indication of how important imperfect competition.

When pure profits are taxed at rate τ_Π, Judd (1995) shows that the long-run optimal choice for τ_D is

$$\tau_D^{opt} = -m\frac{1+\tau_\Pi\ MEB}{1+MEB} \tag{6}$$

where m is the markup of price over marginal cost and MEB is again the marginal efficiency cost of taxation. If the efficiency cost of taxation is zero then the optimal tax completely neutralizes the monopolistic price distortion. This repeats the Robinson finding. As in Diamond-Mirrlees, the optimal tax rate on profits, τ_Π, is 100%, and the optimal policy eliminates the monopolistic price distortion.

While our optimal tax formula (6) is simple, it is not immediately clear that the desirable subsidy is economically significant when we use reasonable

values for the markup m, the profits tax τ_Π, and the marginal excess burden MEB. We assume $m \in [.1, .3]$ as suggested by our discussion of price-cost margins. The range for MEB is taken from Table 2. A key fact is that the equilibrium in our monopolistic competition analysis is essentially the same as for the competitive model used in Table 2 where τ^* from (5) is used as the total effective tax rate on capital income.

Table 4 shows that even if MEB is large, the optimal tax substantially reduces the monopolistic distortion. In Table 4 we assume that $\tau_\Pi = .2$, as proposed in the Flat Tax; we arrive at similar conclusions if we use the pure profits tax rate implicit in any other major tax reform proposal.

Table 4: Optimal Tax Rates

MEB: / m :	.2	.5	1.0	2.0
.05	-.04	-.04	-.03	-.02
.10	-.09	-.07	-.06	-.05
.20	-.17	-.15	-.12	-.09
.30	-.26	-.22	-.18	-.14

Table 4 illustrates a number of points. First, the optimal subsidy is nontrivial in most cases. This shows how a system which puts no tax on asset income would still suffer a substantial distortion relative to the ideal. Second, we find that the productive efficiency principle[8] is still a good indication of optimal policy even though the profits tax is far less than desired by Diamond-Mirrlees. Third, the desire for productive efficiency is strong even in cases where the marginal efficiency cost of taxation is high. The efficiency cost may be high because the revenue need is large or because the elasticity of labor supply is high. In either case, tax policy should still focus on policies which do not aggravate the pre-existing distortions from imperfect competition.

The policy implied by Table 4 is impractical. However, the results in Table 4 indicate how far any income tax system is from optimal. Table 4 also indicates how concerns about the taxation of pure profits are of far less importance than the goal of eliminating productive and intertemporal distortions.

[8]Points about productive efficiency would be better demonstrated in a model with heterogeneous capital goods. The more general analysis in Judd (1995) indicates that these conclusions are strongly supported in such models.

2.4 Benefits of Switching to Consumption Taxation

We next give a quantitative estimate of how monopolistic competition affects our estimates of the gains from switching to a consumption tax. We continue to use the model in Judd (1995). We find that the estimated benefits of switching to a flat consumption tax are substantially increased when we include the presence of imperfect competition.

Since price-cost margins are essentially the same as taxes, we can use the results in Table 2 to draw inferences about the benefits of small tax policy changes. Suppose that capital goods are sold at 20% above marginal cost. We also will assume that there are labor market imperfections such as labor unions which cause wage costs to be 10% higher. Then even if the explicit taxes are $\tau_L = \tau_K = .3$ initially, the economy really begins with $\tau_L = .4$ and $\tau_K = .5$ when we change tax policy. The $\tau_L = .4$, $\tau_K = .5$ case in Table 2 then displays the efficiency impact of alternative tax changes if all marginal profits are taxed away. We see that the marginal benefits of reducing asset income taxation are substantially increased, being at least doubled and often at least tripled. The magnitudes are uncertain since we don't know the values of the critical taste parameters, but the impact of imperfect competition is clear and substantial for any standard estimate.

Table 2 examined small changes. We next examine large changes in tax policy. Table 5 reports the total welfare gain of replacing all income taxation with consumption taxation. Table 5 measures this gain by expressing that percentage change in consumption which is equal to the change in welfare from the tax change. For example, in the case of $\gamma = .25$, $m = 0$, and $\tau_K = .15$, we find that the welfare gain from the switch is equal to an immediate and permanent .12 % increase in consumption[9]. Table 5 examines capital income[10] tax rates of 15%, 25%, and 35%. The rate τ_K represents the marginal tax rate, not the average rate, since the distortion depends on the marginal tax rate. We examine markups of 0%, 10%, and 20%. We assume that depreciation is 5% per year and that capital share is 25%.

[9]This quantity is small, but typical for competitive model. An alternative way to express the welfare gain is to report the ratio of welfare gain to the revenue or revenue change. However, that index is sensitive to the presence of details such as the standard deduction. The index we use is a cleaner way to express the welfare gains which allows us to ignore details which are not relevant for us.

[10]We ignore labor taxation since labor is inelastically supplied in our simple analysis. However, the presence of a wage tax with elastic labor supply generally increases the welfare costs of taxation. Hence, our results are conservative estimates of welfare costs.

Table 5: Welfare Gain (% of Consumption)

		τ_K :	.15	.25	.35
γ	m				
.25	.0		.12	.38	.84
	.1		.37	.79	1.41
	.2		.54	1.08	1.81
.5	.0		.19	.59	1.30
	.1		.57	1.21	2.16
	.2		.81	1.62	2.74
1.1	.0		.24	.76	1.67
	.1		.72	1.54	2.75
	.2		1.00	2.04	3.46

Table 5 shows that the presence of a markup substantially increases the benefits of switching to a consumption tax. In fact, the presence of just a 10% markup often doubles the welfare gain relative to the perfect competition case. Again we find that these gains are substantial for any estimate of the critical parameters.

2.5 Asset Pricing Implications

There is substantial interest in the asset pricing implications of tax reform. In particular, a move to a consumption tax would remove the tax burden on new capital but continue to tax old capital. In a perfectly competitive world where output depends on labor and physical capital alone, competition from new capital could lower the market value of old capital. Gravelle (1995) estimates that the Hall-Rabushka Flat Tax would cause a 20-30% fall in the stock market. This is an important issue which, if true, would create opposition to tax reform.

Gravelle's estimate assumed perfect competition. However, it is unrealistic to assume that most equity is associated with perfectly competitive firms. The value of many firms consists not only of physical capital but of intellectual capital. The value of computer software firms like Microsoft and pharmaceutical firms like Pfizer come from their patents and copyrights, not from their physical plant. Competitive entry is made difficult by patents and copyrights as well as the costs of imitation. While entry may be spurred by the lower tax rates, the R&D process takes time and will have only delayed effects on the profits of incumbents.

Many firms are combinations of physical capital and intellectual capital. Tax reform will reduce the cost of physical capital to each firm, causing more

competition among firms and lower prices. However, if a firm is initially charging a price in excess of marginal cost, the increase in demand will increase his profits. Predictions about asset prices need to be changed in an imperfectly competitive world. The tax analogy is again apt. Firms with market power essentially impose a tax on the product they produce. If the government reduces the tax it imposes on buyers of those products, then one expects the firm to gain pure profits through increased demand for its product. For example, if the tax τ in Figure 3 were eliminated, the firm's profits would increase by the box $H_{\tau m}$. This gain in profits is not present for perfectly competitive producers and is ignored in analyses of asset price changes which assume perfect competition in the product markets[11].

The intuition is clear, and similar to the situation of multiple tax jurisdictions. If the U.S. Federal income tax were repealed and replaced with lump-sum taxation, then output would rise and state income tax revenues would rise. The same is true here where the producers impose a tax on their buyers; a more efficiency U.S. tax system would increase the average firm's sales and increase the revenue from the "tax" it imposes on buyers through the gap between price and marginal cost. In the case of a private firm, these extra revenues, current and future, will be immediately capitalized in the firm value.

The magnitude of these changes is not so clear. The impact in an open economy is clear: if interest rates do not change, then an increase in future profit flows will immediately increase asset values. However, a radical change in U.S. tax policy may produce changes in interest rates in our closed economy model. We need to investigate that possibility to establish the robustness of our general claim that the impact of a consumption tax on asset prices is positively affected by the presence of imperfect competition.

We model this explicitly in the model of Judd (1995) with inelastic labor supply. Essentially, we assume that all goods, final and intermediate, have a common markup, m. A reduction in the tax on capital income will cause an immediate increase in investment and a gradual increase in aggregate output. There will be fluctuations in the share of output devoted to consumption and final goods, but that will not affect aggregate asset values since we assume all goods have the same markup[12].

[11]We always assuming perfect competition in financial markets. We argue that no firm embodies a substantial share of all outstanding equity, and no firm offers a substantially unique risk opportunity.

[12]In a richer model, different firms would sell different goods and experience different asset price changes. For example, those firms who specialize in capital goods would experience an immediate increase in demand whereas those which specialize in consumer goods

Table 6 reports the initial impact on the aggregate market value of equity if we replace an income tax with a lump-sum tax in the model of Judd (1995). In such a tax system, the value of the firm would be equal to the replacement value of its assets if there were no adjustment costs (as we assume) and product markets were perfectly competitive. We assume that the economy is initially in the steady state associated with a tax rate τ_K on all asset income. We also assume that fixed costs of production are so high that there are no extranormal profits in the initial steady state. We examine three cases for the intertemporal elasticity of substitution, γ, two values for the initial income tax rate, τ_K, and two possible values of the markup, m.

Table 6: Initial Increase in Firm Value(%)

		τ_K		
γ	m	.15	.25	.35
.2	.1	1.1	2.0	3.1
	.2	1.8	3.3	5.2
	.3	2.3	4.4	6.8
.5	.1	1.8	3.3	5.4
-	.2	3.0	5.7	9.3
	.3	4.1	7.8	12.9
1.1	.1	2.4	4.5	7.5
	.2	4.1	8.0	13.3
	.3	5.7	11.3	19.1

Table 6 shows that a transition to a lump-sum tax would increase asset values. The impact is small in the cases of small γ because of the slow adjustment in consumption and investment. The case of nearly log utility ($\gamma = 1.1$) and a modest markup of 20% implies that the value of the firm would rise in value by 13% if the marginal tax on equity capital were 35%. If a firm were financed half by debt and half by debt, all of the increased value would go to equityholders, implying an increase in stock market value of 26%.

A Flat Tax would be produce different results but its implications are clear. If the Flat Tax rate were 20%, then the value of a perfectly competitive firm would fall by 20% because the expensing provisions create a 20% wedge between the value of old and new capital. This is the point Gravelle (1995) makes. However, the change in value of a noncompetitive firm would still

would lose sales since the consumption share of output falls in the short-run. However, we assume that all investors are well-diversified, permitting us to focus on aggregate asset values.

be increased by the extra pure profits it would earn. The net change would be equal to the value in Table 6 minus 20%. Similar arguments apply to a VAT or a national sales tax.

In all cases in Table 6, imperfect competition reduces the negative impacts of consumption taxation on the welfare of those, like some elderly, who sell assets to finance consumption. Lyon and Merrill (this volume) discusses asset price implications in greater detail. They make points similar to the ones we make here but do not consider equilibrium impacts on sales and interest rates. Their points further reduce any possible asset price reduction. Our simpler general equilibrium model explores the importance of imperfect competition and ignores many of the other elements considered by Lyons and Merrill. The arguments made here and in Lyons and Merrill reinforce each other, and in combination argue strongly against the pessimistic views expressed in Gravelle (1995).

2.6 Imperfect Competition and Tax Reform

Imperfect competition is a fact of a modern economy, and should be included in any tax analysis. In fact, it is the way we provide incentives for innovation. Capital goods users are already paying a tax in order to finance this investment. While it may not be feasible to relieve that tax burden through tinkering with the tax code, we should still recognize that this private tax means that further taxation of capital goods substantially damages economic efficiency. The presence of this private tax makes it more valuable to move to consumption taxation. The presence of imperfect competition also ameliorates the any negative impact on asset prices since the increase in production increases pure profits in the presence of imperfect competition. Including imperfect competition in our analysis improves the predictions for long-run growth, benefits along the transition, and the immediate impact on asset prices.

3 Risk and Tax Reform

Investment is generally risky, but risk is often ignored in tax reform analyses. This section uses Hamilton's (1986) general equilibrium analysis of the taxation of risky assets to make some basic points. First, we find that asymmetric treatment of risky assets will affect the equilibrium portfolio of the economy. While this is expected, we do this to emphasize the importance of general equilibrium effects since partial equilibrium analyses lead to contrary conclusions. Second, we emphasize Hamilton's finding that there should be

no differential taxation of risky and safe assets. This example indicates that a goal of tax reform should be to eliminate any distortion between safe and risky investments. Third, we analyze the utility-revenue trade-off available to policymakers and demonstrate the importance of incorporating risk in our analysis.

3.1 Asset returns and risk

The most important fact about asset returns in the U.S. is that the annual pre-tax real return to individuals on equity investments has averaged 7% with a standard deviation of 20%, and the mean real return on safe assets has been 1%. Corporate tax adjustments imply that both mean and variance should be 20-40% higher for the risky asset to approximate the opportunities offered to society. The extra return to risky equity is consistent with standard asset pricing theory, but the magnitude is difficult to explain; see Kocherlakota (1996) for a discussion of asset pricing puzzles. The empirical puzzles surrounding asset pricing makes any tax analysis difficult to execute. Even so, we find that including risk in our analysis strengthens the case for consumption taxation.

3.2 Treatment of Risk in the U.S. Income Tax System

The U.S. tax system appears to discriminate against risky assets and in favor of safe assets. This discrimination depends on the type of investment and the manner in which an investor holds it. If an asset is held in a defined contribution pension account, there is no taxation at the personal level. Corporate debt, a relatively safe asset is deducted at the corporate level, implying no taxation of any income generated by such assets. However, income generated by equity investments is taxed at the firm level through the corporate income tax.

For assets held outside of pension accounts, we need to include personal income taxation. At the personal level, dividends and interest income are taxed at the same rate and capital gains have often been taxed at a lower rate. Since the corporate income tax rate is close to or exceeds the personal tax rate, it appears that risky equity investment held outside of tax-favored accounts is taxed at a higher rate than safe debt. These observations indicate that the current U.S. income tax system produces substantial discrimination against risky assets and the investments behind them no matter how they are held by investors. Hubbard (1993) reviews conventional treatments of these issues.

3.3 Hamilton's Model of Risk and Asset Taxation

There have been many analyses of taxation and risk. Domar and Musgrave (1944) argue that an income tax increases risk taking in the economy. However, the Domar-Musgrave result is substantially altered in a general equilibrium context since many risks faced by the government are passed onto private agents and affect private risk taking. Eaton (1981), Gordon(1985), Hamilton (1986), and Kaplow(1994) have analyzed theoretical issues concerning tax systems and risk taking.

Unfortunately, risk is generally absent from quantitative analyses of taxation. This is not surprising since it is difficult to incorporate risk in dynamic general equilibrium analysis. It is also unclear how we should calibrate any such model since we do not understand why there is such a large gap between the mean return of safe and risky assets. However, we should not totally ignore risk in tax reform analyses. We use Hamilton's (1986) model to examine the impact of differential taxation since it focuses on the most basic elements of asset allocation and risk. It allows us to compare consumption taxation, uniform income taxation, and differential income taxation all in one model.

We assume that there are two types of investment projects. We assume that the net income from risky assets is taxed at rate τ_Z and the income from the safe assets is taxed at rate τ_R. We assume that agents have a constant relative risk aversion utility function[13], and discount the future at rate 4% per year.

We assume that all revenues are rebated lump-sum to investors. This is a common assumption we make to abstract from government expenditure policies. In this stochastic context, this assumption takes on added importance. If revenues were destroyed, then, as Domar and Musgrave have argued, a constant income tax would shift investment towards the risky asset. However, we find that assumption to be unrealistic since government expenditures do not immediately react to revenue shocks. The essential idea behind this assumption is that current revenue shocks lead either to tax cuts in the future, or to increases in government expenditures on goods which are good substitutes for private consumption. We do not argue that this is the most valid specification of actual policies, but use it because it is one which allows us to examine the critical issues without modeling fine details of government expenditure policies.

[13]More precisely, we assume $u(c) = c^{1-1/\gamma}/(1-1/\gamma)$, where γ is also the intertemporal elasticity of consumption used in Table 2.

3.4 Utility and Revenue

We use Hamilton's model to examine the trade-off between utility and revenue. We examine several numerical cases. First, we assume that the risky asset has a mean return of 10%, a standard deviation of 25%, and that the safe asset has a mean return of 1%. We do not defend this particular assumption. In any case, we have recalculated the examples below for alternative means and variances, and find that the qualitative points are unchanged.

Hamilton (1987) examined optimal income taxation in such models. He showed that the optimal constant tax policy is to have equal tax rates for safe and risky assets. We examine the global trade-offs among various nonoptimal tax policies.

Figure 4 displays important features for relative risk aversion of 10 (corresponding to $\gamma = .1$ in Table 2.) This may appear to imply a large risk aversion. However, some implications are reasonable. In particular, the standard deviations of consumption and output are about 1%, which is close to observed values.

Figure 4 presents two types of curves relating the tax on the safe asset, τ_R, and the tax on the risky asset, τ_Z. The curves $U_{.1}, U_{.3}$, and $U_{.5}$, are isoutility curves corresponding to the cases where $\tau_R = \tau_Z = .1, .3, .5$. That is, any combination of taxes along $U_{.1}$ produce the same expected utility as the tax policy $\tau_R = \tau_Z = .1$. Expected utility is greater as we move south and west. Similarly, $R_{.1}, R_{.3}$, and $R_{.5}$, are the isorevenue curves corresponding to the cases where $\tau_R = \tau_Z = .1, .3, .5$. The dotted line is the 45 degree line. Revenue increases as we move east and north. A consumption tax is represented at the origin where $\tau_R = \tau_Z = 0$. Note that the isorevenue and isoutility curves are tangent along the 45 degree line, implying that the optimal policy is one of equal tax rates as predicted by Hamilton.

While the optimality implications of Figure 4 correspond to theory, the global trade-offs are strange. Note that revenue is relatively insensitive to changes in the tax on the risky asset. This is not too surprising since most wealth is in the safe asset in Figure 4. More surprising is the shape of the isoutility curves away from the optimal policy. We see that if the tax rate on safe assets is much smaller than the tax rate on risky assets, an increase in tax rates can keep utility unchanged or even improve utility!

These features of Figure 4 shows the importance of including uncertainty explicitly into our analysis. The normal procedure is to take the average pre-tax and post-tax returns and insert them into formulas for utility and revenue in a deterministic model. This approximation will miss incorrectly

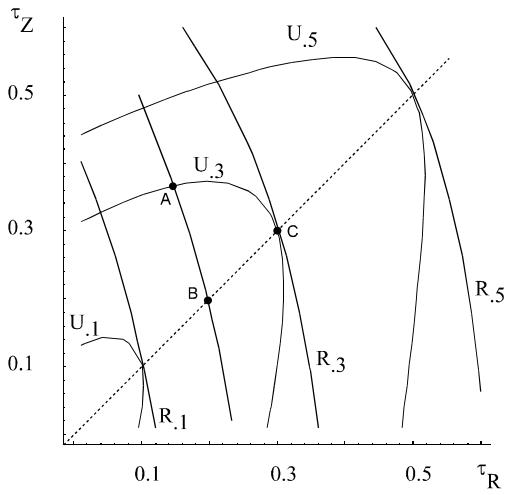

Figure 4:

predict the shape of the isoutility curves since it would predict a uniform fall in utility as tax rates rise.

We can use Figure 4 to make some assessments about the value of converting to consumption taxation and of other less radical reforms. In Figure 4, a constant consumption tax is effectively a lump-sum tax since there are is no labor supply decision. We proceed under the assumption that Figure 4 approximates the welfare gain if labor supply were slightly elastic. Suppose that $\tau_R = .15$ and $\tau_Z = .35$, the situation at point A. The utility-maximizing policy raising the same revenue is at C, implying a small reduction in the tax on risky investments and a larger increase in taxation of safe assets. The optimal revenue neutral change is to move to point B, where utility is higher. The move from A to a consumption tax can be decomposed into two moves, first to a revenue neutral change to a uniform tax at B and then to the origin in Figure 4.

Analyses which ignore the differential taxation of assets will miss the utility gain associated from eliminating nonuniformities, such as the move from A to B. This gain would be achieved even if we just integrated corporate and individual taxation. When we add this feature to the analysis, we find another benefit from moving to consumption taxation.

Table 7 displays the welfare cost of taxation in the Hamilton model of

risk and taxation. We assume that safe assets are taxed at a rate $\tau_R = .1$, and that risky assets are taxed at the rates $\tau_Z = .1, .4$. MEB_R is the marginal excess burden of increasing τ_R, measured as the change in certainty equivalent consumption per dollar of revenue change. MEB_Z (MEB_K) is the marginal excess burden associated with raising a dollar of revenue by a small increase in the taxation of risky asset income (all asset income). We also compute the value of large changes in taxation. To do this, we compute the change in the certainty equivalent of utility, measured in the equivalent constant consumption flow. We compare this to the certainty equivalent of the change in revenue flow. The differential burden DB_R is the value per dollar of revenue change of eliminating differential taxation. TB is the total burden of the initial system of taxation per dollar of revenue.

Table 7: Excess Burden of Taxation with Risky Assets

γ	τ_Z	τ_R	MEB_R	MEB_Z	MEB_K	DB_R	TB
.5	.1	.1	-.10	-.061	-.056	0	-.025
	.4	.1	-1.90	-.510	-.580	-.11	-.220
.1	.1	.1	-.01	-.011	-.002	0	-.005
	.4	.1	.01	-.120	-.037	-.022	-.029

If $\tau_Z = \tau_R = .1$ then safe and risky assets are taxed symmetrically. The total burden is small. However, the marginal burden of introducing any asymmetry is higher than the marginal burden of a uniform increase. In the $\gamma = .5$ column, the total burden of taxation is 2.5 cents, and the marginal burden of asset taxation is 5.6 cents. However, the marginal burden of raising the tax on risky assets only is 6.1 cents. When we examine the asymmetric case of $\tau_Z = .4$ and $\tau_R = .1$, the results are more striking. The gain from eliminating all asset income taxation is 22 cents per dollar of revenue, but the gain of eliminating just the asymmetric treatment, holding fixed total revenue, is 11 cents per dollar of initial revenue. The benefits of reducing asymmetries increases substantially in this case.

These observations even apply to those who hold their equity in 401(k) accounts or similar pension savings accounts. Individual investors still pay taxes on their risky assets through the corporate income tax. In reality, a U.S. taxpayer faces three asset categories - debt, equity, housing - even if he has all financial assets in tax-favored accounts.

The asymmetric tax treatment of assets produces a substantial burden on investors in the Hamilton model. We have examined just one particular model of taxation and risk, but it is a natural one to study. Further investigation of alternative models would be fruitful, but there is no reason to

suspect that the results would be different. The main intuition is clear: if the elasticity of demand for consumption is the same across all states (as is assumed in Hamilton), there is no rationale for asymmetric treatment of income across states. The asymmetric treatment of assets by the U.S. tax code only reduces the efficiency of the U.S. economy.

4 Tax Policy and Human Capital Formation

Human capital is the most important determinant of wealth and income for most individuals and any modern economy. However, income tax analyses devote less effort to understanding the taxation of human capital than the taxation of physical capital and labor supply. A separate treatment is necessary since human capital is neither just capital nor is it just a feature of the labor supply. We show that human capital considerations strengthen the case for consumption taxation, essentially it increases the elasticity of effective labor supply and increases the responsiveness of output to asset income. We also show how it raises new issues about how we should implement a consumption tax.

4.1 Optimal Taxation of Human Capital and Education Investments

Education and other investments in human capital[14] present special problems for tax analysis. Education is an investment good since it increases labor productivity, but it may also have a consumption value. Diamond-Mirrlees (1971) argues for taxing final goods but against taxation of intermediate goods. Since human capital appears to be a mixture of labor supply, investment, and consumption, the implications of these ideas for human capital is unclear.

Judd (1999) examines these issues in a dynamic general equilibrium model. He assumes that individuals invest in both financial assets, A (which finance physical capital, k), and human capital, H. During his life, he earns $\overline{r}A$ in asset income where $\overline{r}$ is the after-tax return on financial assets. He also earns $\overline{w}L(H,n)$ in labor income where $L(H,n)$ is effective units of labor input if he works n hours and his human capital is H, and $\overline{w}$ is the after-tax wage for a unit of effective labor. He allocates savings between financial investments and human capital investment, x. Human capital investments

[14]There are many forms of investment in human capital. We will focus on education and on-the-job training since they are most relevant for tax analyses. Other forms of human capital investment, such as child care and medical care, are even more difficult to analyze.

equal x and earn tax credits at the rate s, implying a net cost of $x(1-s)$. The aggregate production function is $f(k, L(H, n))$ where f is a standard constant returns to scale production function.

The incorporation of human capital in this problem generates a tension. If we think of human capital as capital then the logic in Judd (1985b) argues for no taxation of human capital. That leaves labor income as the only tax in the long-run. However, it is difficult to tax labor income without distorting human capital investments. Judd (1999) shows that if H does not affect utility then human capital is purely an intermediate good and there should be no net taxation on the return of human capital investment, only taxation of hours of labor supply. This can be implemented by taxing labor income but allowing immediate deduction of all human capital investment expenditures. These results follow exactly the logic of Diamond and Mirrlees[15].

4.2 Is Education only an Intermediate Good?

If H is only an intermediate good, then all human capital investments should be expensed. But if H directly affects utility then the analysis in Judd (1999) shows that we want a positive tax on human capital returns. Many components of an education appear to have substantial consumption value. Music appreciation courses in school help one enjoy symphonies and operas later in life. Sometimes the educational activity itself has both productive value and aesthetic value. For example, mathematics courses such as calculus, algebra, and topology not only teach the student highly productive skills, but also introduce the student to the beauty of mathematics and the joy of solving math problems.

We can get evidence about the character of education by comparing financial returns of alternative assets. If education has a lower financial return than comparable financial assets, then human capital must be producing some nonpecuniary utility returns, is partly a consumption good, and should be taxed. This issue has been addressed somewhat in the literature. Becker (1976) argues that years of education and corporate equity have roughly the same mean financial return[16]. Becker (1976) argued (im-

[15]There have been other analyses of human capital and taxation in economic growth models. Jones et al. (1997) argue that there should be no taxation of anything in the long run. This extreme result arises due to special functional form assumptions made in order to arrive at a model with a constant growth rate in consumption and all forms of investment. Judd(1999) examines a strictly more general model.

[16]These are estimates of the social return to education, including any social expenditure

plicitly assuming that education has no final good value) that this showed that there was no underinvestment in education.

Becker's comparison with equity raises the question of why education has as high a risk premium as equity. Previously some economists had argued that there was underinvestment since the return on education exceeded the return on bonds. Unfortunately, there has been little empirical work on this which considers the risky dimensions of human capital returns. Wage income may move with corporate profits, but wages are less cyclical than profits. Furthermore, the price of risk for human capital depends on the relationship between profits and the *marginal* impact of human capital investment on wage riskiness. Since less educated workers are more likely to experience unemployment during a recession, education appears to reduce one's exposure to systematic risk. Therefore, the price of risk to be attached to human capital investments appears to be smaller than that associated with corporate equity. In any case, comparisons with financial assets do not indicate excessive investment in years of education nor do they indicate any consumption component to education. We will proceed under the assumption that education is purely an intermediate good.

4.3 The Importance of Human Capital

We next illustrate the quantitative importance of human capital for tax analyses. We consider a special case of the model described above. We assume that $L(H, n) = H^{\phi}n$ and $f(k, L) = k^{\alpha}L^{1-\alpha}$. If $\phi = 0$, we have a conventional model with only physical capital. We assume $0 < \phi < 1$, implying decreasing returns to human capital investments. As in Table 2, let $\gamma > 0$ be the elasticity of substitution in consumption and $\eta > 0$ the elasticity of labor supply. We highlight the importance of human capital to tax analysis by computing the elasticity of long-run output with respect to the tax and subsidy rates. More precisely, we report percentage change in long-run output, denoted by ε_K, ε_L, and ε_s in response to a 1% change in net-of-tax rates $1 - \tau_K$, and $1 - \tau_L$, on physical capital and labor income, and to $1 - s$, the after-tax cost of human capital investments.

Table 8 reports those elasticities for various values of the critical parameters. We assume that the level of human capital investment equals half of physical capital investment, a conservative choice. We choose ϕ to be .1 or

as well as the direct monetary and time inputs students. While there has been much effort to refine the estimates of the return to years of education, the Becker findings are in the middle range of current estimates, particularly if one adds fringe benefits and other non-wage benefits of education.

.3. The choice $\phi = .3$ implies that a 10 % increase in accumulated human capital investments results in a 3% rise in wages, a conservative choice[17]. Otherwise, we make choose values for γ and η similar to those in Table 2.

Table 8: Elasticity of long-run output to net-of-tax rates

		$\phi = .1$			$\phi = .3$		
γ	η	ε_K	ε_L	ε_s	ε_L	ε_K	ε_s
.5	.1	.51	.21	−.11	.75	.78	−.65
.5	.5	.41	.36	−.09	.55	.84	−.47
.1	.1	.29	.12	−.07	.36	.37	−.31

Table 8 shows how important it is to include human capital in our analysis. We first see that long-run output is sensitive to the treatment of human capital investments. Even in the $\phi = .1$ case, a 10% change in $1 - s$ changes steady state output by about 1%, and the sensitivity can be half as much as the sensitivity of output to labor tax changes. For the $\phi = .3$ case, changes in the treatment of human capital investments are as important as changes in the treatment of labor and capital income. The presence of human capital means that the supply of effective labor $H^{\phi}n$ is more elastic than if human capital had no marginal value. This increase in labor supply elasticity increases the responsiveness of output to asset income taxation and the efficiency cost of capital income taxation.

Table 8 also shows that adding human capital to the analysis increases the benefits from towards a consumption tax. The sensitivity of output to τ_K for the $\phi = .3$ is higher than the $\phi = .1$ case, showing that as human capital becomes more important, the benefits from reducing capital income taxation increases.

To understand the impact of human capital, we examine the allocation of total capital across human and physical capital. The equilibrium allocation ratio is given by

$$\frac{H}{k} = \frac{\phi}{\alpha} \frac{1}{1-\tau_K} \frac{1-\tau_L}{1-s} \tag{7}$$

Equation (7) shows that all three tax policy tools affect the H/k ratio in quantitatively symmetric fashions.

Equation (7) also indicates that new issues arise when we convert from income to consumption taxation. In an efficient allocation, H/k should just

[17]These parameter values are also conservative when compared to a common assumption of $\phi = 1$ in the endogenous growth literature.

equal ϕ/α, the relative factor share coefficients of human and physical capital. Diamond-Mirrlees says that an optimal tax policy would not deviate from this. If we have an income tax where $\tau_K = \tau_L$ but human capital investments are not expensed, $s = 0$, then the H/k ratio is efficient. However, we saw that the inverse elasticity rule says that τ_K should be zero. If we just set $\tau_K = 0$, the resulting H/k ratio would not be efficient. Efficiency would be restored if we also set $s = \tau_L$, which implies that human capital investments should be expensed.

4.4 The Tax Treatment of Human Capital Investments

The U.S. tax code takes a mixed approach to human capital. On-the-job training and a student's own time are both effectively deductible, while expenditures such as tuition and books are generally not deductible. Since on-the-job training and students' time comprise most personal direct expenditures on human capital investments, some have argued that the U.S. tax system treats human capital well; see Boskin(1977) and Heckman(1976) for discussions of this issue.

However, the picture is more complex. The typical analysis treats the large expenditures made by state and local governments on education as subsidies. The Tiebout theory of excludable local publicly provided goods argues against this view. Local and state education expenditures are financed largely by local and state taxation and controlled largely by local and state political entities. The Tiebout view argues that the costs of education are capitalized in the value of land and that public education expenditures are effectively equivalent to private expenditures. The Tiebout view combined with our optimal tax analysis argues that all education expenditures, public and private, should be deducted from the tax base.

A pure subsidy view of education is also contradicted by the presence of rationing. Many college students pay tuition far less than the true cost, but only if they meet certain standards. A pure subsidy view ignores the nonprice rationing associated with higher education and the nonprice costs which are incurred by students competing for those subsidies.

The issue of how to treat educational expenditures is not a minor consideration. In fact, 1990 total expenditures on education (other than Federal aid) was $370 billion compared to $576 billion in gross investment in nonresidential fixed capital. Treating educational expenditures as consumption is similar to taking away all cost recovery from equipment investment, a proposal which would not be regarded as minor.

The Tiebout model is an extreme one, but the main point is robust. In

general, the idea is that citizens of most communities decide to finance the education of their children together through local taxes. In any rational model of political decisionmaking, these expenditures will respond to their after-tax cost. Feldstein and Metcalf (1987) offer evidence that local expenditures are affected by Federal Income tax rules. To the extent that state and local tax deductions affect investment in human capital, some deduction is desirable.

This is currently accomplished partially in the current tax code through the deductibility of state and local income and property taxes in the Federal income tax, but this affects only a part of educational expenditures. Some parents pay substantial non-deductible tuition to send their children to private schools. Also, itemization is more common among high income families, implying a regressive tax on human capital accumulation. The consumption tax principle plus the intermediate good view of human capital argues for the deductibility of all public and private expenditures in all communities.

The Flat Tax (see Hall and Rabushka, 1983), consumption tax (see Bradford, 1986), the hybrid tax of McLure and Zodrow(1996), the USA tax (see Weidenbaum, 1996), and value added (VAT) and national sales tax (NST) proposals all argue for a consumption tax but define "consumption" as income minus investment in physical capital only. The various tax proposals differ little on their treatment of human capital investments. The Hall-Rabushka-Armey-Forbes Flat Tax proposals clearly allow few deductions for educational investments other than on-the-job training; the sales tax and VAT proposals are similar. The USA tax allows limited deductibility of some educational expenses. All would eliminate the deduction for state and local taxation which finances most educational expenditures. On the other hand, the Flat Tax would reduce the tax rate on labor income, improving incentives for human capital investment as indicated in (7).

It is not immediately clear if the current consumption tax proposals hurt or help human capital formation relative to the current tax system. However, it is clear that the treatment of human capital is important. Even if consumption tax reform does not help human capital directly, Table 8 shows that the presence of human capital strengthens the case for reducing the tax burden on investment in general.

5 Distributional Concerns

We have focused on aggregate output and investment in this paper, and ignored distributional concerns. Before ending, we should address these concerns. Our main argument is that they are not as severe as they might

appear, and that the human capital issues addressed in the previous section suggest ways to ameliorate some distributional concerns.

5.1 Worker versus Capitalists

A key feature of most current radical tax reforms is the elimination of taxation on new investment and reduction of taxation on the current capital stock, replacing it with taxation on wage income and consumption. This is the feature which accounts for much of the predicted increase in investment and output. A shift to wage taxation would seem to hurt workers. The counterargument is that the increase in capital accumulation would increase worker productivity and wages, resulting in higher worker welfare. This argument is often dismissed by consumption tax opponents as too weak, slow, and indirect.

Optimal tax theory presents a very strong argument in favor of eliminating investment income taxation. Above we presented the argument why taxation of asset income in the long-run damages aggregate productivity. This argument also holds when we consider the impact on workers and capitalists. Judd (1985b) shows that even if the government were in control of tax policy and gave to workers all the receipts from asset income taxation, it would still choose to have no taxation of asset income in the long-run. There is no benefit to workers to permanently distort asset accumulation because the major effect of long-run asset taxation is to reduce total investment and labor productivity.

The optimal tax results may appear to be only long run results with little force for the foreseeable future. We next investigate the transition process of tax reform by asking how would capitalists and workers share in tax reform if we make a small change in the current tax structure. Table 9 (taken from Judd, 1984) assumes that the economy[18] is in the steady state with a capital income tax rate of τ_K and an investment tax credit θ[19] and computes the change in revenue and wages from a small decrease in τ_K or a small increase in θ, using increases in wage or consumption taxation to finance any shortfall in revenue. Each dR (dW) entry in Table 9 is the change, expressed as a percentage of capital income, in the present value of capital income tax revenue (present value of wage income) caused by

[18]As in Table 2, we assume a representative agent model with inelastic labor supply.

[19]The investment tax credit proxies for any investment incentive above economic depreciation. In particular, it proxies for accelerated depreciation as well as an explicit ITC. We assume here that the ITC is on all investment, not just equipment. This assumption is consistent with the nature of consumption tax proposals.

a 1% change in τ_K or θ. If there were no change in savings, dR would equal 1 and dW would equal 0. We examine a variety of values for γ, the intertemporal elasticity of substitution in consumption, and for σ, the elasticity of substitution between capital and labor. We assume that τ_K is initially either .3 or .5. We assume that θ is initially .05, representing the presence of an explicit ITC or accelerated depreciation.

The results in Table 9 address many issues. The values for γ and σ substantially affect the magnitudes of the revenue and income changes. However, we do see some patterns. First, the impact on wages is often substantial. It is small only when γ is small, cases where the transition process is slow. In the other cases, a 1 percentage point decrease in τ_K or a 1 percentage point increase in θ increases wages by .4-1.4% of total capital income, a substantial change. Also, wages are affected almost equally by a 1% change in either τ_K or θ. Second, changes in θ affect total revenue by less than changes in τ_K. Therefore, the ITC is a much more potent tool for increasing wages and labor productivity. This is not surprising since the ITC affects only new investment whereas reductions in τ_K reduce taxation of old capital as well as new investment. Table 9 shows that the ITC can produce the same improvement for wages at substantially less revenue loss.

Table 9: Disaggregated Effects of Small Tax Changes

		$\tau_K = .3$				$\tau_K = .5$			
		Decrease τ_K		Increase θ		Decrease τ_K		Increase θ	
σ	γ	dR	dW	dR	dW	dR	dW	dR	dW
.7	1.00	-1.02	.93	-.50	1.10	-1.05	1.35	-.52	1.33
	.25	-1.01	.60	-.49	.70	-1.03	.87	-.51	.85
1.0	1.00	-.91	.85	-.38	1.00	-.79	1.24	-.28	1.22
	.25	-.95	.50	-.42	.59	-.88	.74	-.36	.72
1.3	1.00	-.83	.79	-.27	.93	-.58	1.16	-.06	1.13
	.25	-.90	.44	-.37	.52	-.77	.64	-.25	.62

Third, increases in the ITC could be close to self-financing. The dR numbers in Table 9 consider only capital income tax revenue. When we add a reasonable wage tax rate we find that total revenues may rise when we increase θ. For example, consider the first line. If $\tau_K = .3$ initially, then a marginal increase in θ raises before-tax wage income by \$1.10 for every \$.50 of revenue loss from capital income taxation. If the marginal labor income tax rate were .45, the extra labor tax revenue would equal \$.50 and there would be no net loss in revenue. A labor tax rate of .45 is larger than current labor taxation, implying that some increase in labor

taxation would be necessary to balance the budget. If $\tau_K = .5$ initially, the second set of columns indicate that we only need a .35 marginal tax rate on labor income (a plausible description of the current tax system if we include Social Security taxes) for ITC increases to be self-financing. The possibility of self-financing ITC increases is not unusual in Table 9. In the case of Cobb-Douglas technology ($\sigma = 1$) and log utility ($\gamma = 1.$) we need at most a .38 marginal tax rate on labor income in the low initial tax rate case. Self-financing decreases in τ_K are much more unusual, being plausible only with a high elasticity of substitution between capital and labor.

In any case, the substantial improvement in before-tax wages means that we would need only a small tax rate increase on consumption or wages to balance the budget. More important, even if they had to pay for an ITC increase, the workers would be almost always be better off since dR is usually less than dW. Only when γ is substantially smaller than the values in Table 9 does the revenue loss exceed the wage increases. On the other hand, this is less likely, albeit not implausible, for reductions in τ_K.

The analysis in Judd(1984) is biased in favor of consumption taxation because of the absence of adjustment costs. However, the estimates in Table 9 are conservative since they ignore the elements of imperfect competition which we have argued are important. In particular, if we include imperfect competition in our analysis, the $\tau_K = .5$ case in Table 9 becomes the more relevant initial condition since Table 3 showed that imperfect competition substantially increases the effective total tax rate on capital income.

Distribution issues are important in making the case for consumption taxation. We have seen that the productivity enhancing properties of even a small movement towards consumption taxation would have beneficial effects for most even when we consider the transition process.

5.2 Old versus Young

We have used representative agent models of the economy in this paper. This approach ignores intergenerational effects, assuming that all agents live "forever" and are, effectively, the same age. An alternative paradigm often used in tax analysis is the overlapping generations (OG) approach. Theoretical analyses, such as Atkinson and Sandmo(1980) have used two-period OG models. Auerbach and Kotlikoff(e.g., see Auerbach and Kotlikoff, 1987) have used a version where agents live for 55 periods. In such a world, people differ in age, wealth, and planning horizons. Any tax reform could affect different cohorts very differently, and affect future generations very differently than current generations. The OG approach allows us to analyze

generational issues ignored in representative agent models. We next compare these approaches and the importance of intergenerational elements for tax policy analysis.

The representative agent approach is arguably a good approximation for questions of aggregate dynamics. It is not that representative agent analyses literally assume that agents live forever, nor that agents have perfectly altruistic attitudes towards their children. The real question for aggregate analysis is the relative planning horizon of the typical agent, flexibility in his dynamic behavior, and his view of the future. Compare, for example, the classic two-period OG model of Samuelson, and the typical Auerbach-Kotlikoff (AK) model. In the Samuelson model these models, each agent lives for only two periods, youth and old age. If we were to interpret the Samuelson model, we would have to say that each agent at age 20 chooses a constant consumption demand and labor supply for 25 years, and then at age 45 gets to change those levels to other levels which are constant for the next 25 or so years. Such inflexibility is clearly unrealistic. In the AK version, each agent is economically active for 55 distinct periods (modeling ages 20 through 75), allowed to change consumption and labor decisions in each year. The extra flexibility in the AK version makes it a much more realistic model. The extra flexibility produces much more sensible descriptions of the transition process after a tax reform and allows us to use empirical analyses which similarly assume annual or similarly frequent observations of agents' decisions.

The key difference between the AK model and a representative agent model is the length of life of the typical agent, but it is not clear how important these differences are given the level of discounting typically used. Both Auerbach and Kotlikoff and those who use representative agent models assume that agents discount the future at an annual rate of 4% or thereabouts. This implies that a young person at age 20 treats a dollar at age 75 as being equal to 12 cents at age 20. The difference between the representative agent model and the AK model is that the utility derived between ages 20 and 75 constitute 88% of lifetime utility for an infinitely lived agent and 100% of lifetime utility in the AK model in the absence of a bequest motive.

The representative agent and AK models are similar in their predictions of aggregate output and dynamics. For any fixed utility function and production function, the two models differ, but we know neither tastes nor technology with precision. The range of predictions of the two models are similar once we examine the wide range of empirically sensible taste and technology specifications.

The major difference lies in implications for specific individuals. The

advantage of the AK model is that it can be used for intergenerational distribution analyses. That cannot be disputed. Using the AK model, Auerbach (1996) raises important concerns about the intergenerational impact of tax reform. The problem is that a transition to a consumption tax would cause older taxpayers to pay a new tax on their accumulated savings (either through consumption taxation of the proceeds of asset sales or through a fall in the market value of their assets) but that they would not live long enough to enjoy the benefits.

However, it is unclear how we should interpret the Auerbach results. Consider, for example, the demographic structure of the AK model. It assumes that all die at age 75. These demographic assumptions are inaccurate on two accounts. First, death is an uncertain process[20] and many people live longer than 75 years. Table 10 compares life expectancy in the AK model and in the U.S. In fact, in the U.S., a 75-year old has a life expectancy of 11 years, not 1. When an AK model says that a 75-year-old loses from a tax reform because of a drop in asset prices, that loss presumably arises because his life expectancy is just one year. If AK predicts that anyone younger than 60 gains, that is presumably because anyone with more than a 15-year life expectancy gains, and that those people gain because any immediate short-run loss is balanced by gains over the following 15 years. When we translate this interpretation to U.S. demographics, it appears that AK predicts that anyone younger than 67 would gain from consumption tax reform since a 67-year old has about a 16 year life expectancy in the U.S.

[20]In our discussions we will assume that there is an actuarially fair annuity market. If such markets did not exist then an income tax may be desirable as a way to share life expectancy risk. In general, when capital markets are not perfect, income taxation may dominate consumption taxation. See Hubbard and Judd (1986, 1987, 1988) for analyses of taxation with capital market imperfections. Future work should integrate the considerations of Hubbard and Judd with the concerns of this paper to determine the relative strength of these conflicting forces.

Table 10: Life Expectancy in A-K Model and U.S.

Age	A-K Model		U.S. Adult Population	
	Life Expectancy	Fraction Older	Life Expectancy	Fraction Older
55	21	.32	25.1	.29
60	16	.24	21.1	.23
65	11	.16	17.4	.18
67	7	.13	16.1	.16
70	6	.08	14.1	.13
75	1	.01	11.0	.08
80	(NA)	(NA)	8.3	.04
85+	(NA)	(NA)	6.1	.02

Source: Table 119 of the 1998 Statistical Abstract of the U.S.

The second, and more important difference between the AK demographic specifications and U.S. demographics is the distribution of life expectancy. Suppose that the AK model predicts that all individuals older than 60 loses. That encompasses 24% of the population, a sizable voting block. Auerbach (1996) argues that transition relief to compensate them would substantially limit the possible long-run gains from tax reform. This conclusion is not surprising given the large number of individuals who would be harmed. Also, the AK analysis assumes that a large fraction of the population would be substantially harmed. For example, the 8% of the population in the AK model have less than a 6-year life expectancy. It will be particularly difficult to compensate them since the available horizon is so short.

The U.S. demographic situation is not so grim and does not present as large a challenge to transition relief. More precisely, only those older than 67 have less than a 16-year life expectancy, and they constitute only 16% of the population, not the 24% in AK. The fact that the affected population is smaller would make it easier to construct compensatory policies. Also, there are far fewer who are substantially affected. For example, those with only a 6-year life expectancy would likely suffer greater losses than the average loser and constitute 8% of the population in AK but only 2% in the U.S.

This issue becomes even more ambiguous when we incorporate marriage into the analysis. Suppose a husband and wife have a life expectancy of 15 years. Since their deaths are uncertain and somewhat independent, the expected time until both die would be greater than 15 years. If there is some altruism between husband and wife, then the effective household life expectancy is greater than 15 years.

Our analysis of asset prices with imperfect competition is also relevant

here. We saw that when we add imperfect competition to our analysis, the switch to a consumption tax would reduce asset prices by less than the increase in pure profits to producers. Other features of tax reform reinforce these points. Auerbach (1996) assumed that there are no unrealized capital gains. In reality, older taxpayers hold considerable amounts of equity on which they have not yet paid capital gains taxes. A consumption tax reform would forgive the unpaid income taxes on those unrealized capital gains. In fact, when one integrates the reduction in capital gains taxation with any reasonable fall in asset prices it is quite plausible for an older taxpayer to enjoy a gain in disposable income.

Both the representative agent and overlapping generations models are highly stylized models with important differences in their demographic structure. Overlapping generations models are capable of analyzing intergenerational incidence issues. However, these incidence results will be very sensitive to the demographic and tax policy details. The conclusions of analyses such as Auerbach (1996) seem to be overly pessimistic.

5.3 Middle-Income versus Upper-Income

One of the unfortunate features of many consumption tax proposals is that middle-income groups gain relatively little whereas upper-income groups gain much more in the short-run. The reasons are clear. Middle-income taxpayers lose key deductions such as the home mortgage interest deduction and the state and local tax deductions. The reduction in asset income taxation is of less value to them because most of their assets are already in tax-favored vehicles, such as owner-occupied housing and pension fund accounts. Their ability to shelter asset income is growing under the current system as we increase the scope, size, and liquidity of those special accounts. Upper income groups benefit more from the rate reductions and the elimination of asset income taxation since their savings exceed the contribution limits of pension accounts.

This distribution problem indicates that consumption tax reform need to be altered in order to form the necessary political coalition. One alternative is to keep the mortgage interest deduction, but this would be bad news for resource allocation. One of the primary benefits of the Flat Tax and similar proposals is that it would eliminate the current bias towards housing investment and against nonresidential business fixed investment. Since the housing stock is of roughly the same size as other forms of capital, this reallocation of investment would substantially improve economic efficiency in the long run. If we maintain the mortgage interest deduction in the long

run, we would be losing one of the primary benefits of the Flat Tax.

An alternative idea is to allow some state and local tax deductions, possibly tied to educational expenditures. This alternative would redirect some tax relief to the middle class, and is no worse in terms of simplicity than allowing some form of the mortgage interest deduction. The incidence would be similar to the mortgage interest deduction since both are strongly related to income. Allowing some deductions tied to education would be consistent with the principles of consumption taxation, whereas the mortgage interest deduction is a clear violation of the conceptual foundations of consumption taxation.

Table 11 displays the magnitudes of the estimated tax revenue cost of various deductions in the current tax system. We see that the revenue cost of the home mortgage interest deduction is roughly equal to the revenue loss from state and local tax deductions for households. The size of these tax expenditures reflects the current marginal tax rate. The actual revenue loss would be less under a Flat Tax with a marginal rate of 20% or less. The mortgage interest deduction and state and local tax deductions appear to have roughly the same budgetary consequences. One suspects that they also have similar distributional impacts. The benefits of the mortgage interest deduction is perhaps more focused on the middle class since it is capped and since the top income groups spend less of their income on housing than the middle class. Of course, one suspects that any mortgage interest deduction included in a modified Flat Tax proposal would also be capped, implying that a cap on state and local tax deductions would add no greater complexity than a capped mortgage interest deduction.

Table 11: Major Tax Expenditures, 1998 ($billion, est.)

Home Mortgage Interest Deductions	51.2
State and Local Tax Deductions:	
Owner-occupied housing	17.7
Other nonbusiness deductions	32.1

Source: Table 544, *Statistical Abstract of the U.S.*, 1998

We have focussed on the educational expenditures of state and local government. While education is the major expenditure of state and local government, a deduction tied to those expenditures would be smaller than the current state and local tax deduction. We have argued that education is an intermediate good whether financed privately or through local governmental entities, and that its tax treatment should not depend on the organizational form individuals decide to use. This argument suggests that

we ask the same question of other public services, such as police, fire, and the judicial system. If they are intermediate goods then they too should be excluded from a consumption tax base.

A far more detailed examination of the nature and allocation of local publicly provided goods is needed. Our conjecture is that such an analysis will produce proposals which deal with transition and distribution problems without deviating much from the underlying goals of consumption taxation.

6 Conclusions

Economists have argued that there are large long-run gains from switching to a consumption tax, but some have argued that there are difficult distribution and transition problems. Earlier arguments have been unduly pessimistic because they have ignored many important elements. When we include some of the features of the U.S. economy which makes it a modern and technologically advanced economy, such as imperfect competition, human capital accumulation, and risk, we find that the case for a consumption tax is substantially strengthened.

Imperfect competition is a ubiquitous feature of a modern economy, but it acts as a tax on the U.S. economy. We show that it is particularly damaging in the investment goods sector. Innovation in intermediate goods is financed by allowing imperfect competition in intermediate goods industries. This imperfect competition reduces the productive efficiency of the economy. Any tax on capital income inflicts even more damage on the incentive of the economy to make desirable investments. We show that the gains from eliminating the tax burden on capital income is particularly large.

The current tax system discriminates against risk-taking since equity-financed investments pay more taxes than debt-financed investments. This bias has no rational purpose and distorts the allocation of capital. Analyses which ignore this feature of the current tax system substantially underestimate the value of moving to a consumption tax or more modest integration proposals.

Human capital is an important part of any modern economy and makes labor productivity more sensitive to tax policy. Moving to consumption tax will not only increase investment in physical capital but also increase wages and the incentive to invest in education and other forms of human capital, producing an even greater increase in long-run output.

These considerations dramatically affect our estimates of the benefits of moving to a consumption tax. Overall, estimates of the long-run benefits

are easily doubled and often tripled by incorporating these elements into our analysis.

These new considerations also help with transition problems. Imperfect competition effects will push up stock market values, reducing any adverse effects of tax reform for older taxpayers. We also argue that concerns about intergenerational equity are also alleviated when we take a realistic view of life expectancy. When we consider the role of education as an investment, we see that deductions for educational expenditures may be used to reduce middle-class losses from tax reform without continuing the inefficient preference for owner-occupied housing.

At a more fundamental level, we argue that a proper understanding of tax systems show that an income tax is a particularly bad form of consumption taxation, and that the current tax system violates most principles of good tax policy. The choice of tax systems is an important and difficult one, but the case for good consumption taxation, as embodied in various proposals, is strong and growing stronger.

References

Aaron, Henry J., Harvey Galper, and Joseph Pechman, eds. *Uneasy Compromise: Problems of a Hybrid Income-Consumption Tax*, Brookings: Washington, D.C. 1988.

Appelbaum, E. "The Estimation of the Degree of Oligopoly Power," *Journal of Econometrics*, **19** (1982): 287–299.

Atkinson, Anthony B., and Agnar Sandmo. "Welfare Implications of the Taxation of Savings," *The Economic Journal* **90** (September, 1980).

Atkinson, A., and Stiglitz, J. "The Structure of Indirect Taxation and Economic Efficiency." *Journal of Public Economics* **1** (1972), 97–119.

Auerbach, A. J. "The Optimal Taxation of Heterogeneous Capital," *Quarterly Journal of Economics* **93 (**1979), 589-612.

Auerbach, A.J., and L. Kotlikoff. *Dynamic Fiscal Policy*, Cambridge: Cambridge University Press, 1987

Auerbach, Alan J. "The Deadweight Loss from 'Non-neutral' Capital Income Taxation," *Journal of Public Economics* **40** (October, 1989): 1-36.

Auerbach, Alan J. "Tax Reform, Capital Accumulation, Efficiency, and Growth," in: Henry J. Aaron and William G. Gale, eds., *Economic Effects of Fundamental Tax Reform*, The Brookings Institution: Washington, D.C., 1996.

Balcer, Y., I. Garfinkel, K. Krynski, and E. Sadka. in *Social Policy Evaluation: An Economic Perspective*, E. Helpman, A. Razin, and E. Sadka, eds. Academic Press: New York, 1983.

Barro, Robert J., and Xavier Sala-i-Martin. *Economic Growth,* McGraw-Hill: New York, 1995.

Becker, Gary. *Human Capital: A Theoretical and Empirical Analysis.* Chicago and London: University of Chicago Press, 1976.

Boskin, M. "Notes on the Tax Treatment of Human Capital." *In U.S. Department of Treasury Office of Tax Analysis, Conference on Tax Research 1975.* Washington, D. C: U.S. Government Printing Office, 1977, pages 185-195.

Bradford, D. *Untangling the Income Tax*, Cambridge: Harvard University Press, 1986

Diamond, P. A. "Taxation and Public Production In a Growth Setting." In *Models of Economic Growth*, J. A. Mirrlees and N. H. Stern (eds.), 215-234, London, Macmillan, 1973.

Diamond, P. A. and Mirrlees, J. A. "Optimal Taxation and Public Production," *American Economic Review*, **61** (1971), 8-27 and 261-278.

Domar, Evsey D., and Richard A. Musgrave. "Proportional Income Taxation and Risk-Taking." *Quarterly Journal of Economics* **58** (May, 1944): 388–422.

Domowitz, Ian, R. Glenn Hubbard, and Bruce C. Petersen, "Business Cycles and the Relationship between Concentration and Price-Cost Margins," *Rand Journal of Economics* **17** (Spring 1986a), 1–17.

Domowitz, Ian, R. Glenn Hubbard, and Bruce C. Petersen, "The Intertemporal Stability of the Concentration-Margins Relationship," *Journal of Industrial Economics* **35** (Sept. 1986b), 13–34.

Eaton, J. "Fiscal Policy, Inflation and the Accumulation of Risky Capital," *Review of Economic Studies* **48** (1981), 435-45.

Hall, R. E. and Rabushka, A. *Low Tax, Simple Tax, Flat Tax*, (McGraw-Hill, New York), 1983

Feldstein, M. S. "The Rate of Return, Taxation and Personal Savings," *Economic Journal* **88** (1978) 482-487.

Feldstein, M. S., and Metcalf, G. E. "The Effect of Federal Tax Deductibility on State and Local Taxes and Spending," *Journal of Political Economy* **95** (1987), 710–736

Gordon, R. H. "Taxation of Corporate Capital Income: Tax Revenues versus Tax Distortions," *Quarterly Journal of Economics* **100** (1985): 1-27.

Goulder, L. H., and P. Thalmann. "Approaches to Efficient Capital Taxation: Leveling the Playing Field vs. Living by the Golden Rule," *Journal of Public Economics* **50** (February, 1993): 169-96.

Gravelle, J. *The Economic Effects of Taxing Capital Income*, Cambridge: MIT Press. 1994.

Gravelle, Jane. "The Flat Tax and Other Tax Proposals: Who Will Bear the Tax Burden?" CRS Report for Congress 95-1141E, November 29, 1995.

Hall, Robert E. and Alvin Rabushka. *Low Tax, Simple Tax, Flat Tax*, (McGraw-Hill, New York), 1983.

Hall, Robert E. "Market Structure and Macro Fluctuations," *Brookings Papers on Economic Activity,* (2, 1986), 285-322

Hamilton, J. H., 1987. "Taxation, Savings, and Portfolio Choice in a Continuous Time Model." *Public Finance* **42**, 264-82.

Heckman, James. "A Life-Cycle Model of Earnings, Learning , and Consumption," *Journal of Political Economy*, , **84**(4, August 1976), pp. S11-S44.

Hubbard, R. Glenn, and Kenneth L. Judd. "Liquidity Constraints, Fiscal Policy, and Consumption" *Brookings Papers on Economic Activity*, v0 (1, 1986), pp. 1-50.

Hubbard, R. Glenn, and Kenneth L. Judd. "Social Security and Individual Welfare: Precautionary Saving, Borrowing Constraints, and the Payroll Tax," *American Economic Review* **77** (4, September, 1987), pp. 630-46.

Hubbard, R. Glenn, and Kenneth L. Judd. "Capital Market Imperfections and Tax Policy Analysis in the Life Cycle Model," *Annales d'Economie et de Statistique* v0(9, Jan.-Mar, 1988), pp. 111-39.

Jones, L., R. Manuelli, and P. Rossi. "Optimal Taxation in Models of Endogenous Growt," *Journal of Political Economy* **101**(3, June 1993), pp. 485-517.

Jorgenson, Dale W, and Kun Young Yun. "Tax Reform and U.S. Economic Growth," *Journal of Political Economy*; **98** (Number 5, October, 1990), S151-93.

Judd, Kenneth L. "On the Performance of Patents," *Econometrica* **53** (3, May 1985), pp. 567-85.

Judd, Kenneth L. "Redistributive and Efficiency Effects of Capital Tax Changes in a Dynamic Model," mimeo, 1984, Northwestern University.

Judd, Kenneth L. "Redistributive Taxation in a Simple Perfect Foresight Model," *Journal of Public Economics* **28** (October, 1985):59-83.

Judd, Kenneth L. "The Welfare Cost of Factor Taxation in a Perfect Foresight Model," *Journal of Political Economy* **95** (August, 1987).

Judd, Kenneth L. "The Optimal Tax on Capital Income is Negative," Hoover Institution, mimeo, 1995.

Judd, Kenneth L. "Optimal Taxation and Spending in General Competitive Growth Models," *Journal of Public Economics* (1999).

Kaplow, Louis. "Taxation and risk taking: a general equilibrium perspective." National Tax Journal **47** (1994): 789-798.

Kocherlakota, Narayana R. "The Equity Premium: It's Still a Puzzle," *Journal of Economic Literature*, **34** (March, 1996), 42-71.

McLure, C., and Zodrow, G. R., 1996. "A Hybrid Approach to the Direct Taxation of Consumption." In *Frontiers of Tax Reform*, edited by Michael Boskin, Hoover Press: Stanford, CA.

Robinson, Joan. *The Economics of Imperfect Competition,* London: MacMillan. 1934.

Stiglitz, J. E., and Dasgupta, P., 1971. "Differential Taxation, Public Goods, and Economic Efficiency," *Review of Economic Studies* 38, 151-174.

U. S. Department of the Treasury, *Integration of the Individual and Corporate Tax Systems: Taxing Business Income Once*. Washington, D. C.: U. S. Government Printing Office, 1992.

Weidenbaum, M., 1997. "The Nunn-Domenici USA Tax," In *Frontiers of Tax Reform*, edited by Michael Boskin, Hoover Press: Stanford, CA

Statistical Abstract of the United States: 1998. U.S. Department of Commerce.