Income Taxes as Reciprocal Tariffs

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This article explores the parallel between the standard theory of income taxation and the theory of tariffs in international trade. Insights from the theory of tariffs help us understand how income taxes undercut the very basis on which people gain from trade—specialization.

Public finance experts have long explored the issue of income taxes making the cost of market transactions higher than nonmarket ones. A 50 percent income tax, for example, requires $20,000 in income to purchase $10,000 of market goods. The tax can be avoided, however, if the same goods can be produced at home. The upshot is that income taxes encourage the home production of goods and services that would otherwise be produced and traded in the market. By restricting trade between individuals, income taxes reduce what Adam Smith considered one of the primary benefits of the marketplace—the gains to specialization.

Given that income taxes reduce specialization within an economy, it is easy to see the similarities between the taxing of income within a country and tariff barriers between countries: income taxes encourage individuals to trade less in the marketplace and produce more goods at home; tariffs cause countries to trade less internationally and produce more domestically. Moreover, just as tariffs can redistribute income across countries, flat income tax rates can redistribute income across skill groups. Over a range of positive flat income taxes (tit-for-tat tariffs), raising taxes may actually benefit large groups of similarly skilled individuals (large countries) and hurt the small groups (small countries). Other insights into the effects of income taxation can also be elucidated from tariff theory. As in tariff theory, the costs of income taxes are small only if they succeed in raising revenue; thus, it seriously harms an economy to be on the downward portion of the tax revenue (Laffer) curve. The larger the value of market income (trade) compared with total production (gross domestic product)—that is, the more heterogeneous the society—the higher the income tax rate that maximizes revenue.

This article explores the parallel between the standard theory of income taxation and the theory of tariffs in international trade. Indeed, there is no formal difference in economic theory between a tariff war among countries and a flat-rate personal income tax within an economy. But although analysts generally consider tariff wars extremely costly to economic activity, they often look on income taxes with complacency.[1] One possible reason for these different reactions is that tariff wars are explicitly used to inflict damage on another country, whereas income taxes are used primarily to finance public spending. This article looks at how insights from the theory of tariffs can help us understand the effects of income taxation.

HOME PRODUCTION AND INTERNATIONAL TRADE

As noted above, income taxes shift production from market work to home production. Eisner (1989) estimates that the total value of U.S. home production ranges from 20 percent to 50 percent of measured output (GDP). In Sweden, a country with one of the highest marginal income tax rates in the world, home production accounts for an even larger part of domestic output. Swedish men, for example, averaged more than four hours per week on home improvement activities in 1984. In contrast, U.S. men averaged 2.8 hours and Japanese men less than one hour a week (Juster and Stafford 1991).[2] Trade theorist Ivor Pearce succinctly sums up the effect of taxes on the division of labor:

> The striking growth of do-it-yourself activity in recent years is neither an accident nor a change in basic preferences. Tax is avoided on work for self. Work for an employer is heavily taxed. The cheapest way to get something done is to do it yourself, contrary to the principle of the division of labor on which our high present standards of living depend. The whole structure of industry is deeply affected (Pearce 1977, 105–6).

The effect of income taxes on home production and market specialization has not gone unnoticed in economics. Boskin (1975) combines the household sector with a market sector to examine taxes in a general equilibrium framework. His two-sector model includes capital and labor as factors of production, but labor is untaxed in the household sector. Apps (1981, 1982) uses the analogy of trade theory to examine inequality issues that arise when certain groups of individuals are excluded from the market sector. Sandmo (1990) explicitly shows the similarities between income taxes and tariffs in his examination of optimum tax structures in a Becker-style model (Becker 1965) of household production. Sandmo notes that when household production is included, production efficiency is no longer feasible because "taxes on households are in fact tariffs on their trade with the rest of the economy" (Sandmo 1990, 89). In his framework, however, it is assumed that households must make market purchases, so the household equivalent of international autarky is ruled out. Extensive work on household production and taxation can be found in the literature on real-business-cycle theory. In McGrattan, Rogerson, and Wright (1997), for example, private consumption goods come from market and nonmarket production. Nonmarket goods are produced from domestic capital and labor allocated to home production. Because real-business-cycle models typically assume a representative agent, they cannot analyze how taxes affect individuals with different skills, which this article examines.

In international trade theory, home production is not tied to any good or sector; it is simply anything produced domestically. In tax models, however, a separate household sector typically produces only household goods distinct from those produced in the market sector. Consequently, in representative agent tax models, putting high income taxes on market transactions may reduce the market sector's size and change relative prices, but it will not generate the contrasting experiences of different individuals and the autarkic tendencies of tariff theory.

In the real world, nearly all households produce cleaning, cooking, entertainment, transportation, repair, and many other services. While relatively few goods may be produced at home, households' purchase of durable goods (refrigerators, computers, stoves, lawnmowers, and so on) enables the production of many services. Because of the tremendous diversity in skills and behavior, households cannot be treated as a single representative agent. Households will respond differently to income taxes, just as countries respond differently to tariffs. Thus, departing from the approach of Sandmo (1990) and McGrattan, Rogerson, and Wright (1997), we do not set out a separate household sector or identify a unique household good. All production can be consumed at home or "exported" to the market.

The results of this approach show effects normally not associated with income taxes. Over some range of positive flat income taxes, raising tax rates may benefit a relatively large sector of an economy at the expense of a smaller sector. For example, if manufacturing is the largest sector in an economy, it may benefit from a flat income tax at the expense of agriculture. In a two-person economy, the high-income individual may benefit at the expense of the low-income individual. This is similar to tariff theory, in which large countries may gain from tariffs at the expense of small countries. Flat income taxes, in essence, can boost some economic sectors at the expense of others and dramatically reduce specialization within an

economy. Representative agent models overlook this aspect because they treat everyone as identical. In the real world, each household activity competes with its counterpart in the market economy. Taxes that shift activity away from the market will have redistributional effects outside the purview of representative agent models.

As in tariff theory, the costs of income taxes are small only if they succeed in raising revenue; thus, it is very costly for an economy to be on the downward side of the tax revenue (Laffer) curve.

We also examine the effects of income taxes on general welfare. Here we find that the impact of income taxes depends in a complex way on the heterogeneity of the society.

INCOME TAX THEORY

To consider the theory of income taxation in a heterogeneous agent economy, suppose there are two agents, households 1 and 2, producing two goods, 1 and 2. Each household can produce and consume both goods, one of which is "imported" and the other "exported." Comparative advantage determines which good the household exports (sells) and which it imports (buys). Household i produces and consumes amounts x_j^i and c_j^i of each good j. Household i's utility function is

$$u^i(c_1^i, c_2^i), \tag{1}$$

and its production transformation function is

$$T^i(x_1^i, x_2^i) = k^i. \tag{2}$$

This implicit function shows the maximum output of one good given the output of the other. The function is set equal to the constant k^i, reflecting household i's fixed endowments of capital and labor. The subscript j on a function denotes the partial derivative. Thus, u_j^i denotes household i's marginal utility of good j. Applying the implicit function rule to Equations 1 and 2, we let $MRS^i = u_2^i/u_1^i$ and $MRT^i = -T_2^i/T_1^i$ denote the marginal rates of substitution in consumption and transformation in production, with T_j^i denoting household i's marginal resource cost of good j. Since only relative prices matter, we let p denote the market price of good 2 in terms of good 1. As a convention, we suppose agent 1 (agent 2) always sells good 1 (good 2) and buys good 2 (good 1).

Because taxing household production or consumption is not feasible (imagine trying to tax home cooking or parents' caring for their children), we assume the government imposes taxes only on market transactions. These taxes are essentially income (or, equivalently, sales) taxes. We examine the effects of an income tax, τ, levied ad valorem on each household as a proportion of its net dollar sales, or market income. As a benchmark for the analysis, we assume all income tax receipts, R^i, are directly rebated to each household in the amount paid to the government, but each household treats this as a lump-sum amount independent of any decision the household might make. This device allows us to investigate the distortionary effects of taxation per se, exclusive of the effect of resources absorbed by government.

Each household converts domestic production into domestic consumption through market transactions. Each household's lump-sum tax receipts plus net income (after taxes) must equal market expenditures. Thus, the budget constraints of households are

$$R^1 + (x_1^1 - c_1^1)(1 - \tau) = p(c_2^1 - x_2^1), \tag{3}$$

(tax receipts for household 1 + income from selling good 1 = purchases of good 2)

and

$$R^2 + (x_2^2 - c_2^2)p(1 - \tau) = (c_1^2 - x_1^2). \tag{4}$$

(tax receipts for household 2 + income from selling good 2 = purchases of good 1)

Household 1 chooses (x_j^1, c_j^1) to maximize the Lagrangian

$$\mathcal{L}^1 = u^1(\bullet) + \lambda T^1(\bullet) + \mu[R^1 + (x_1^1 - c_1^1)(1 - \tau) - p(c_2^1 - x_2^1)],$$

which yields the first-order conditions

$$MRS^1 = MRT^1 = p/(1 - \tau). \tag{5}$$

Household 2 chooses production and consumption to maximize

$$\mathcal{L}^2 = u^2(\bullet) + \lambda T^2(\bullet) + \lambda[R^2 + (x_2^2 - c_2^2)p(1 - \tau) - (c_1^2 - x_1^2)],$$

yielding

$$MRS^2 = MRT^2 = p(1 - \tau). \tag{6}$$

The remaining equations are the transformation function (Equation 2) and market clearing:

$$\Sigma_i c_2^i = \Sigma_i x_2^i. \tag{7}$$

We rebate to each household the exact revenue collected by the government. That is,

$$R^1 = \tau(x_1^1 - c_1^1); \tag{8}$$

$$R^2 = \tau p(x_2^2 - c_2^2). \tag{9}$$

Substituting Equations 8 and 9 into Equations 3

and 4, respectively, yields the tax-free budget constraints

$$x_1^i + px_2^i = c_1^i + pc_2^i. \quad (10)$$

Equations 2, 5, 6, 7, and 10 consist of nine equations and nine variables for determining the levels of household production, consumption, and p.

Table 1
Tariff Theory Versus Income Tax Theory

Tariff theory	Income tax theory
$MRS^1 = MRT^1 = p(1 + t^1)$	$MRS^1 = MRT^1 = p/(1 - \tau)$
$MRS^2 = MRT^2 = p/(1 + t^2)$	$MRS^2 = MRT^2 = p(1 - \tau)$
$\Sigma_i c_2^i = \Sigma_i x_2^i$	$\Sigma_i c_2^i = \Sigma_i x_2^i$
$x_1^i + px_2^i = c_1^i + pc_2^i$	$x_1^i + px_2^i = c_1^i + pc_2^i$
$T^i(x_1^i, x_2^i) = 0$	$T^i(x_1^i, x_2^i) = 0$

TARIFF THEORY

This section summarizes the traditional theory of tariffs (see Jones 1969; Ruffin 1979) in a form that is useful for comparison with income tax theory and in a way that parallels our development of the theory of income taxation.

Countries 1 and 2 produce goods 1 and 2, respectively. Country i exports good i. The world price of good 2 in terms of good 1 is p. The domestic relative price of good 2 is p^i. Country i imposes the ad valorem tariff rate t^i on the point-of-origin price (Lerner 1936). Since country 1 imports good 2, the domestic price of good 2 is higher than the foreign price:

$$p^1 = p(1 + t^1). \quad (11)$$

Since country 2 exports good 2, the domestic relative price is lower than the world price:

$$p^2 = p/(1 + t^2). \quad (12)$$

Substituting households for countries, we can use the same notation as before for describing utility in country i and production possibilities.

We make the usual assumption in tariff theory that all tax revenues are redistributed in lump-sum form to consumers. We could proceed as before, but note that this assumption is automatically captured if the rates of substitution and transformation are set equal to the domestic price ratio and the value of exports equals the value of imports at world prices, or, equivalently, the value of production equals the value of consumption at world prices. Thus, the fundamental equations of tariff theory are:

$$x_1^i + px_2^i = c_1^i + pc_2^i; \quad (13)$$

$$MRS^1 = MRT^1 = p(1 + t^1); \quad (14)$$

$$MRS^2 = MRT^2 = p/(1 + t^2); \quad (15)$$

$$\Sigma_i c_2^i = \Sigma_i x_2^i; \quad (16)$$

$$T^i(\bullet) = 0. \quad (17)$$

Equation 13 describes the spending constraints, Equations 14 and 15 set out the private optimization conditions, Equation 16 gives the market-clearing conditions, and Equation 17 relates the supply constraints. There are nine independent equations (two each for Equations 13, 14, 15, and 17) to solve for the nine variables. Table 1 compares the theory of income taxation with the theory of tariffs. It is obvious that they are formally equivalent provided

$$(1 + t^i) = 1/(1 - \tau). \quad (18)$$

The theory of tariffs can thus be interpreted as the theory of sales taxation if countries are seen as households.[3]

Income taxes work heavily against market production because they act like reciprocal tariffs, which impose the same tariff rate on each country. Table 2 uses Equation 18 to show the reciprocal tariff equivalents for different income tax rates. While a 10 percent income tax is the same as an 11 percent reciprocal tariff (each country imposes the same tariff), an income tax of 33.33 percent is like a reciprocal tariff of 50 percent. A 50 percent income tax is equivalent to a 100 percent tariff. In the parlance of tariff theory, income taxation has potentially large antispecialization effects. Income taxes are, in effect, a government-sponsored tit-for-tat tariff war between individuals.

Table 2
Reciprocal-Tariff Equivalents to Income Taxes

Income tax rate (Percent)	Reciprocal-tariff equivalent (Percent)
10	11
20	25
25	33
33	50
50	100

WELFARE

In this section we analyze the welfare implications of income taxes in the same way economists examine tariff theory (see Jones 1969). As a benchmark for the analysis, we continue to assume all income tax receipts are directly rebated to each household in the amount paid to the government. $E_j^i = c_j^i - x_j^i$ is household i's excess demand for good j. In market equilibrium, one household's excess demand will just offset another household's excess supply. Use $p^i = MRS^i = MRT^i$ to denote household i's opportunity cost in terms of good 2. Household i's change in real income is defined as

$$dy^i = dc_1^i + p^i dc_2^i. \tag{19}$$

Equation 19 is derived from the utility function itself and is the total differential of utility measured in terms of the numeraire good, good 1. We can convert the change in utility to market variables by differentiating the budget constraint (Equation 10) and using Equation 19, noting that along the production transformation curve $dx_1^i + p^i dx_2^i = 0$. Thus,

$$dy^i = (p^i - p)dE_2^i - E_2^i dp. \tag{20}$$

This well-known equation in trade theory also applies to households. If household i is a net buyer of good 2 (that is, imports good 2 because $p^i > p$), the change in welfare is the household's personal profit, $(p^i - p)dE_2^i$, on additional purchases minus the increase in the cost of previous purchases, $E_2^i dp$.

We first use Equation 20 to show that sufficiently high taxes always reduce welfare. Suppose taxes are so high that each household is driven to autarky ($E_2^i = 0$). Working backward from autarky, we see that welfare increases as taxes are reduced:

$$dy^i \big|_{E_2^i = 0} = (p^i - p)dE_2^i > 0.$$

This inequality follows from Equation 20 because initially $E_2^i = 0$ and $dE_2^i > 0$ when taxes are reduced. In other words, welfare falls as we increase taxes and approach autarky.

Another result is that increases in income taxes are the most costly when the economy is on the downward side of the tax revenue (Laffer) curve. Without loss of generality, we can look at household 2, where $(p^2 - p) = -p\tau$. Taxes paid (and rebated) to this household are $R^2 = (p^2 - p)E_2^2$. The change in revenue is

$$dR^2 = (p^2 - p)dE_2^2 + (dp^2 - dp)E_2^2. \tag{21}$$

Substituting Equation 20 into Equation 21 yields

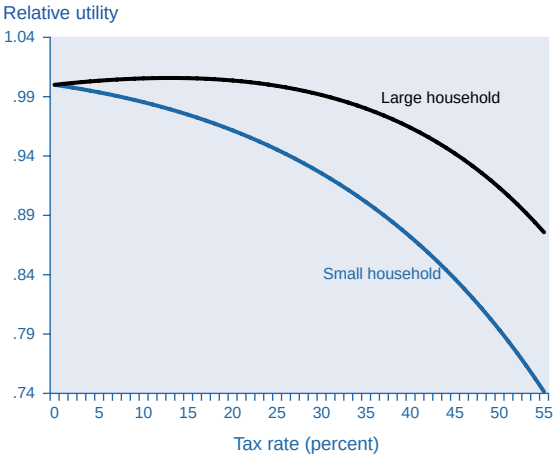
$$dy^2 = dR^2 - dp^2 E_2^2. \tag{22}$$

Any increase in τ will reduce the net price of good 2 to household 2 when it sells the good in the market, so $dp^2 < 0$. Because household 2 is a net seller of good 2, its excess demand for the good is negative, so the second term in Equation 22 is negative (the product of three negatives). This shows that when there is any change in income taxes and tax payments are rebated in a lump sum, welfare can only increase if the lump-sum payment increases. In other words, increments in the income tax hurt the most when the economy is on the downward side of the tax revenue function. If tax revenues are maximized at, say, $\tau = 0.2$, doubling τ from 0.05 to 0.1 will have a smaller impact on welfare than increasing τ from 0.2 to 0.25.

The most interesting implication of Equation 20 is that an equal change in income taxes across all households will not necessarily affect everyone in the same manner. In our model, taxation causes each individual to produce less of the good he or she sells. But taxation can also change the relative price of goods, which benefits one household and hurts the other. This differential impact arises from the ambiguous effect a change in the income tax rate, τ, can have on the terms of trade, p. As income taxes are raised, the terms-of-trade effects are ambiguous because the offer curves of both households shift inward. If households are asymmetrical in terms of their production possibilities and preferences, the terms of trade will change as the offer curves shift inward at different rates, and the relative price of one good will most likely increase. For example, an income tax may lower a plumber's demand for doctors' services proportionately more or less than it lowers a doctor's demand for plumbers' services.

Thus, when households are not symmetrically different, some will experience an improvement in their terms of trade and find their welfare increasing over a range of income taxes. Just as a large country can gain at the expense of a small one by imposing an optimal tariff to improve its terms of trade, some households may gain at the expense of others when income taxes are imposed. The proof of this proposition is straightforward. Starting from zero income taxes, $(p^i - p) = 0$, Equation 20 shows that a household experiencing an improvement in the terms of trade from income taxes ($dp < 0$ and $E_2^i > 0$, or, $dp > 0$ and $E_2^i < 0$) will find its welfare enhanced:

Figure 1
Unequal Household Incomes



$$dy^i \Big|_{\tau = 0} = -E_2^i dp > 0. \tag{23}$$

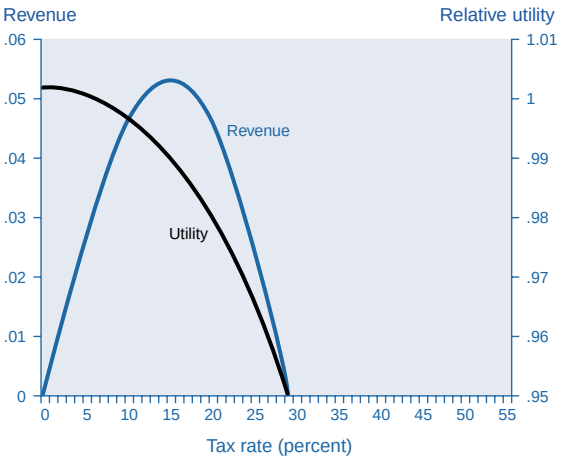
Likewise, the household that experiences a deterioration in its terms of trade will find its welfare declines: $dy^i \Big|_{\tau = 0} < 0$. Equation 23 shows that a small tax improves the welfare of the party whose terms of trade improve. This is because $E_2^1 + E_2^2 = 0$, so that facing the same change in market price, dp, one household is better off and the other worse off.[4]

Thus, we see that a sufficiently small income tax of the sort being considered (tax rebated in a lump sum) will usually help some groups. Which groups will benefit? The answer can be found by looking at income taxes as tit-for-tat tariff wars. It is easy to see that large countries will win a matching tariff war: they can improve their terms of trade because they have a larger impact on world prices. A similar result obtains here. In the case of flat income taxes, the consumer with the higher income will benefit from higher taxes over a certain range. Say the high-income person sells financial services to a low-income person in return for painting. Starting from a zero flat income tax rate, increasing tax rates will raise the market price of both financial services and painting. The high-income person will demand less painting, and the low-income person will demand fewer financial services. However, because the high-income person consumes relatively more painting than the low-income person consumes financial services, the relative demand for painting will fall more than that of financial services. The high-income person's demand falls by more because a higher income essentially means that demand curves are flatter (all else equal). Therefore, the price of painting should fall relative to financial services. At the margin, starting from no taxes, this benefits the high-income person and hurts the low-income one. This result of our model should not be interpreted as meaning that in the real world income taxes hurt low-income people more than high-income people. This result applies to larger similarly skilled *groups* versus smaller ones. Thus, if high-income individuals in the real world represent a small share of total production and if their comparative advantage overlaps little with that of low-income individuals, flat income taxes would affect them more adversely.

Figures 1, 2, and 3 show some illustrative calculations for several hypothetical economies (see the box entitled "Model Description" for a characterization of the hypothetical economies). It is assumed that the utility and product transformation functions display a constant elasticity of substitution. Figure 1 shows a typical case in which household 2's income is roughly twice that of household 1. As income taxes are increased, household 2's utility rises while that of household 1 falls. Indeed, household 2's real income is maximized when the tax rate is approximately 13 percent, and its real income does not fall below that associated with no taxes until the tax rate is 25 percent. Thus, the redistribution effects can be significant.

Figures 2 and 3 consider the case of equal-income households. In Figure 2 the households are largely homogenous, with small differences in their comparative advantages. In Figure 3 the households are distinctly heterogeneous. In the symmetrical cases the utility of each household behaves in the same way. As the income tax increases, nothing happens to the market price because the increase in demand from one party

Figure 2
Small Differences in Comparative Advantage, Equal Household Income



Model Description

The model underlying the simulations in Figures 1–3 is as follows:

$$U_1 = (c_{11}^{\rho} + c_{12}^{\rho})^{1/\rho}$$

$$U_2 = (c_{21}^{\rho} + c_{22}^{\rho})^{1/\rho}$$

$$x_{11}^{\alpha} + Bx_{12}^{\alpha} = k_1$$

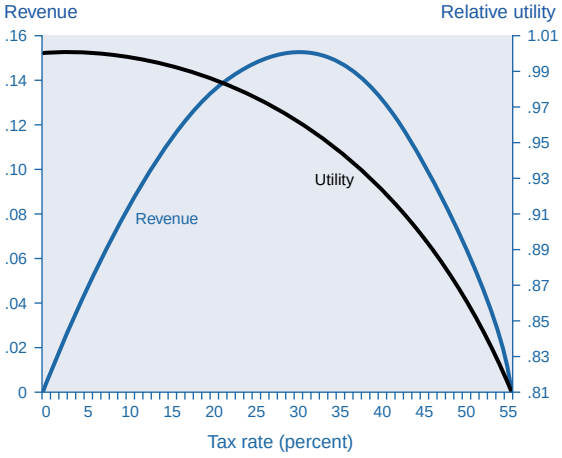
$$Bx_{21}^{\alpha} + x_{22}^{\alpha} = k_2,$$

where $\rho = 0.5$, $\alpha = 1.5$.

In Figure 1, $B = 2$ and $k_1 = 1$ and $k_2 = 2$.
In Figure 2, $B = 2$ and $k_1 = k_2 = 1$.
In Figure 3, $B = 5$ and $k_1 = k_2 = 1$.

equals the reduction in demand from the other. Real income falls from the outset; the optimal income tax for both households is zero, as could be expected. The revenue, or Laffer, curve is also shown. In Figure 2 the revenue function reaches its maximum at an income tax of 15 percent and revenue falls to zero when both parties are reduced to autarky (no exchange) with an income tax rate of 29 percent. In the autarky case, both parties lose about 5 percent of their welfare relative to the zero income tax position. In Figure 3, with large differences in comparative advantage (greater heterogeneity), maximum revenue is achieved at a tax rate of 30 percent, and autarky is reached at a tax rate of 55 percent. In this case, with taxes that choke off all trade, both parties lose about 20 percent of the welfare they would have with no income taxes.

Figure 3
Large Differences in Comparative Advantage, Equal Household Income



CONCLUSION

Traditionally, income taxes have been seen as lowering society's output through the household's labor–leisure trade-off. Income taxes lower the after-tax wage rate and thus encourage people to work less and enjoy more leisure. However, income taxes also reduce the degree to which individuals specialize in market activity, which is similar to the way countries respond to tariffs in international trade. Income taxes discourage individuals from specializing in activities that reflect their comparative advantage. Instead, they encourage everyone to become a jack-of-all-trades. In so doing, income taxes may have their most distorting effects not by encouraging individuals to work less but by causing them to spend more time working at endeavors in which their talents do not lie.

As long as it is necessary to raise revenue, the autarkic tendencies of income taxes, sales taxes, and value-added taxes are unavoidable. The only solution would be to minimize them by imposing lump-sum supplements to these antispecialization taxes. But, as the experience of the Thatcher government in Britain illustrates, even small poll taxes are highly unpopular. Income taxes are thus likely to remain the primary source of government revenue.

Nevertheless, the ways in which income taxes affect society's welfare must be recognized. By focusing mostly on the labor–leisure trade-off and ignoring heterogeneity in the workforce and the potential for workers to flee to home production, policymakers may under- or overestimate the effect income taxes have on various sectors of the economy and thereby tax with unintended consequences. Just as in trade among nations, where equal tariffs can wreak more economic destruction in some nations than in others, in the day-to-day commerce within a nation even flat income taxes can have differing deleterious effects. They affect the very basis on which people gain from trade—the ability to specialize.

NOTES

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[1] Indeed, the protectionist trade war triggered by the Smoot–Hawley tariff may have contributed significantly

to the Great Depression. See, for example, Wanniski (1978), Chapter 7, "The Stock Market and the Wedge," for a discussion of this topic.

[2] Moreover, according to the same article, Swedish men averaged 39.8 hours of market work and 18.1 of housework (including home improvements) per week, whereas U.S. men averaged 44 hours of market work and 13.8 hours of housework.

[3] Furthermore, we have shown that sales taxes are equivalent to income taxes even in the presence of household production. See Mieszkowski (1967, 251) for a lucid statement of the equivalence of income taxes and sales taxes in a world without home production.

[4] Of course, the country as a whole is made worse off because the terms-of-trade improvement for some households is more than offset by the terms-of-trade loss to the households that experience a fall in their terms of trade. This can be demonstrated by Equation 20. Welfare is maximized when $dy^1 + dy^2 = 0$, which implies that tax rates are zero.

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