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9 Optimal Tax Policy for Balance of Payments Objectives

Kent P. Kimbrough

The proper role of tax policy in open economies has been and continues to be an area of considerable interest to economists.[1] Boadway, Maital, and Prachowny (1973) and Dasgupta and Stiglitz (1974) consider optimal tax policy in an open economy in the Ramsey sense of maximizing welfare subject to a revenue constraint. The principle result emerging from these two papers is that revenue considerations do not justify the introduction of tariffs and other barriers to international trade—the only sound welfare theoretic case for enacting trade barriers is the optimum tariff argument. Along similar lines, Razin and Svensson (1983a) study the optimal response of tax rates and budget deficits to permanent and temporary productivity shocks. They show that, starting from a stationary state, both permanent and temporary drops in productivity call for permanent increases in tax rates while only temporary declines in productivity call for any change in the government's budget (it should go into deficit when productivity is unusually low). Kimbrough (1986a) extends Razin and Svensson's setup and examines the optimal response of tax rates, government spending, and budget deficits to inflows of foreign aid to the public and private sectors. He shows that tax rates should be permanently reduced and government spending on public goods permanently increased in response to an inflow of foreign aid accruing to the public sector, while just the reverse is optimal when the increment in foreign aid accrues to the private sector. Persson and Svensson (1986) consider how the public debt can be restructured over time so that the optimal tax policy will be time consistent, paying

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particular attention to the differences in the required restructuring of the debt for large and small economies.

Another major strand of the literature on the role of tax policy in open economies, in addition to studies based on the Ramsey tax problem and its open economy implications, has dealt with the optimum use of tax policy to mitigate distortions and achieve noneconomic objectives (see, for example, Johnson 1965 and Bhagwati 1968). The literature on the optimum structure of taxation for the attainment of noneconomic objectives has concentrated exclusively on microeconomic goals such as achieving a target level of output in the import-competing sector, a target level of imports, or a minimum level of employment in a given industry. However, many important policy questions concern the appropriate use of tax policy for macroeconomic objectives. For instance, one of the oldest and most pervasive arguments put forth in favor of tariffs, quotas, capital controls, and other barriers to international flows of goods and capital is that such policies are useful devices for improving a nation's trade balance and correcting balance of payments difficulties. Indeed, such sentiments were the cornerstone of the policy prescriptions of the mercantilists which Adam Smith attacked in *The Wealth of Nations*. More recently, large and rising U.S. trade deficits, about 3.4% of GNP in 1984 and up from 1.4% in 1982, have led Congress to consider enacting a 20% across-the-board tariff. Work by Mussa (1974, 1976) and Razin and Svensson (1983b) sheds considerable light on the likely impact of these and other policies. Mussa demonstrates that levying a tariff will only temporarily improve the balance of payments; the most reliable way to permanently improve the balance of payments is to reduce the rate of domestic credit creation. Razin and Svensson show that while temporary tariffs improve the current account by making current goods relatively more expensive in terms of future goods, the current account effects of permanent tariffs are ambiguous.

Given that the impact of tariffs and other taxes on the balance of payments and the trade balance are by now fairly well understood, it seems appropriate to study the optimal structure of taxation for achieving various balance of payments objectives. The purpose of this paper is to examine, from the perspective of the literature on noneconomic objectives, the optimal tax policies for achieving various balance of payments related objectives. The aim is to provide a general welfare theoretic framework for studying optimal policies concerning balance of payments and other international finance related objectives. The basic framework of analysis is the traditional two-sector model of international trade theory and public finance modified to include both monetary considerations and intertemporal decision making. To this end the cash-in-advance, exchange economy setup of Helpman (1981) is extended to a two-good, production economy setup.[2] This framework is used to consider four balance of payments–related objectives. First, the optimal tax policy for attaining a trade balance target is examined. Second, the closely related issue of a target level for domestic wealth is discussed. Optimal taxation for achieving a target level of international reserve holdings by some prespecified date is the third issue to be studied. Finally, the optimal tax policy for a balance of payments target is outlined.

The paper is organized as follows. Section 9.1 describes the economy. In section 9.2 the representative agent's optimization problem is discussed, and in section 9.3 the economy's general equilibrium is outlined. Sections 9.4–9.7 examine the optimal tax structure for attaining a trade balance target, a wealth target, a target level of international reserves, and a balance of payments target. Concluding remarks are presented in section 9.8.

9.1 Description of the Economy

Consider a small open economy that produces and consumes two traded goods. The economy is inhabited by an infinitely-lived representative agent whose goal is to maximize his lifetime utility, U, which is given by

$$U = \sum_{t=1}^{\infty} \rho^{t-1} U(X^t, Z^t), \tag{1}$$

where $0 < \rho \leq 1$ is the agent's subjective discount factor and X^t and Z^t are his consumption of the two goods in period t. The pattern of international trade may vary over time; in some periods good Z may be imported and in others it may be exported, and similarly for good X. Production in each sector is subject to constant returns to scale, and it is assumed that the factors of production, labor and physical capital, are in fixed supply. In each period t the representative agent has two sources of income. First, the agent produces and sells his output of the two goods, X^t_s and Z^t_s, at the producer's relative price p^t_s. In terms of good X this provides the agent with income of $X^t_s + p^t_s Z^t_s$. Producer prices may differ from consumer prices, p^t, and the world terms of trade, p^{*t}, due to the presence of taxes and subsidies on production, consumption, and international trade. In addition to his income from goods production, the agent also receives transfer payments from the government that have a value of τ^t in terms of good X.

Domestic residents can also transact in domestic and world bond markets, although transactions in the world market may be subject to taxes, subsidies, or capital controls. In period t the representative agent can buy or sell real bonds denominated in terms of good X. On the world market one of these bonds yields $1 + r^{*t}$ units of good X in period $t + 1$, where r^{*t} is the world real interest rate. However, the return to domestic agents in period $t + 1$ is $1 + r^t$ which may differ from the world return due to the previously mentioned distortions.

The monetary mechanism of exchange dictates that agents must use domestic currency to buy domestically produced goods and foreign currency to buy foreign produced goods.[3] Agents satisfy their demand for goods by purchasing them first from domestic suppliers and then from foreign suppliers. Therefore, if good X is exported in period t and the agent purchases X^t units of the good he will use his current holdings of domestic money, M^t, to buy them. Likewise, if good Z is imported in period t, his purchases of imports $Z^t - Z_s^t$, will be financed out of his holdings of foreign money, M^{*t}.

The sequencing of transactions in the economy is the same as that adopted by Helpman (1981) in his comparison of exchange-rate regimes and by Greenwood and Kimbrough (1987) in their investigation of foreign exchange controls. For purposes of outlining the sequencing of transactions a sketch of one period of the representative agent's life will now be given. Throughout this sketch it is assumed for illustrative purposes that good X is exported and good Z is imported in period t. The agent enters period t with a certain amount of the two currencies left over from period $t - 1$. At the beginning of the period he receives domestic currency from his sales of goods in the previous period. That is, at the start of period t the agent receives $P^{t-1}(X_s^{t-1} + p_s^{t-1}Z_s^{t-1})$, where P^{t-1} is the domestic currency price of good X in period $t - 1$. At the same time the agent also receives his transfer payments from the government which have a nominal value of $P^t\tau^t$.

Next, the agent enters the bond and foreign exchange markets. He receives income from the bonds he purchased last period of $P^t(1 + r^{t-1})b^{t-1}$ units of domestic currency and buys new bonds worth P^tb^t. Having completed his bond market transactions the agent enters the foreign exchange market and allocates his cash holdings between domestic and foreign money in the amounts M^t and M^{*t}. A unit of foreign currency exchanges for e^t units of domestic money, where the exchange rate, e^t, may either be market determined or pegged by the domestic government.

During the last part of period t the agent uses the cash he has acquired to buy goods. He then enters period $t + 1$ with $M^t - P^t(X^t + p^tZ_s^t)$ units of domestic currency and $M^{*t} - P^{*t}p^t(Z^t - Z_s^t)$ units of foreign currency, where P^{*t} is the foreign currency price of good X. Arbitrage in the world market for good X guarantees that $P^t = e^tP^{*t}$, $t = 1,2 \ldots$. However, because of taxes and subsidies on domestic consumption and production, there are wedges between the exchange rate adjusted foreign nominal price of good Z and the domestic nominal prices facing consumers and producers.

9.2 The Agent's Optimization Problem

The representative agent makes consumption, production, and asset choices so as to maximize his lifetime utility as given by (1). This maximization is subject to the budget constraints facing the agent, the cash-in-advance constraints implied by the monetary mechanism of exchange, and the production technology and factor supplies with which the agent is endowed. Given the setup of the problem the agent's production decisions will be made so as to maximize the present value of his output. Assuming that domestic markets are perfectly competitive, the solution to this problem yields output supply functions with the standard properties:

$$(2) \qquad X_s^t = \underset{(-)}{X_s^t(p_s^t)}, \qquad Z_s^t = \underset{(+)}{Z_s^t(p_s^t)}, \qquad t = 1,2, \ldots,$$

where the signs under the arguments of the supply functions show the signs of the partial derivatives of the supply functions. Since the supply functions in (2) maximize the value of output, $X_s^t + p_s^t Z_s^t$, the envelope theorem implies that

$$(3) \qquad \frac{-\ \partial X_s^t/\partial p_s^t}{\partial Z_s^t/\partial p_s^t} = p_s^t, \qquad t = 1,2 \ldots.$$

Given his production choices as characterized by (2) and (3), the agent chooses X^t, Z^t, $m^t = M^t/P^t$, $m^{*t} = M^{*t}/P^{*t}$, and b^t for $t = 1,2, \ldots$ to maximize (1) subject to the following constraints for $t = 1,2, \ldots$ (the convention here is that all period zero variables are identically zero):

$$(4) \quad m^t + m^{*t} + b^t = \frac{P^{t-1}}{P^t} [X_s^{t-1}(p_s^{t-1}) + p_s^{t-1}Z_s^{t-1}(p_s^{t-1})] + \tau^t$$

$$+ (1 + r^{t-1})b^{t-1} + \frac{P^{t-1}}{P^t} \{m^{t-1} - \omega[X^{t-1} + p^{t-1}Z_s^{t-1}(p_s^{t-1})]$$

$$- (1 - \omega) [X_s^{t-1}(p_s^{t-1}) + p^{t-1}Z^{t-1}]\} + \frac{P^{*t-1}}{P^{*t}} \{m^{*t-1}$$

$$- \omega p^{t-1}[Z^{t-1} - Z_s^{t-1}(p_s^{t-1})] - (1 - \omega) [X^{t-1} - X_s^{t-1}(p_s^{t-1})]\},$$

$$(5) \qquad \omega[X^t + p^tZ_s^t(p_s^t)] + (1 - \omega) [X_s^t(p_s^t) + p^tZ^t] \leq m^t,$$

$$(6) \qquad \omega p^t[Z^t - Z_s^t(p_s^t)] + (1 - \omega) [X^t - X_s^t(p_s^t)] \leq m^{*t},$$

where ω is an indicator variable that equals one when good Z is imported and zero when good Z is exported. (To keep the notation simple the possibility that both goods might be imported or exported in the same period has been ignored.) Equation (4) is the agent's period t

budget constraint while equations (5) and (6) are the cash-in-advance constraints confronting the agent in period t.

In the current framework, money is required for transactions purposes but agents choose whether or not to hold money as a store of value on the basis of wealth maximizing considerations. As discussed by Helpman (1981) and Greenwood and Kimbrough (1987), so long as domestic and foreign inflation rates, $\pi^t \equiv (P^{t+1} - P^t)/P^t$ and $\pi^{*t} \equiv (P^{*t+1} - P^{*t})/P^{*t}$, exceed the rates dictated by the optimum quantity of money rule, $-r^t/(1 + r^t)$ and $-r^{*t}/(1 + r^{*t})$, bonds will dominate money as a store of value and the cash-in-advance constraints, (5) and (6), will hold as equalities. These conditions, which imply positive nominal interest rates, are assumed to hold in the remainder of the analysis.

Treating (5) and (6) as equalities and using them in (4), it is straightforward to show that maximization of (1) subject to the resulting constraint yields, in addition to the constraint itself, the familiar first-order conditions

$$U_Z^t/U_X^t = p^t, \quad t = 1,2, \ldots, \tag{7}$$

$$\rho^{t-1}U_X^t/U_X^1 = d^t, \quad t = 1,2, \ldots, \tag{8}$$

where $d^t \equiv \Pi_{j=1}^{t-1} (1 + r^j)^{-1}$, $d^1 \equiv 1$, and $U_j^t \equiv U_j(X^t,Z^t)$ is the period t marginal utility of good j, $j = X,Z$. Within-period consumption choices are made so as to equate the marginal rate of substitution between the two goods to the consumer's relative price, p^t. The intertemporal allocation of consumption is such that the marginal rate of substitution between goods in period 1 and period t is equal to the domestic real discount factor, d^t.

9.3 General Equilibrium

In addition to the representative agent whose consumption, production, and asset plans have just been described, the economy has another actor: the government. Like the representative agent the government must satisfy a budget constraint. For the discussion of optimal tax policy that follows it is useful to artificially divide the government into two branches. One branch of the government is the fiscal authority. They finance real transfer payments of $\tau^t - \mu^t$ from the net revenues collected from the taxes and subsidies they levy on production, consumption, international trade, and international borrowing and lending. The fiscal authority's budget constraint, which is not written out formally since the distorting taxes to be levied are yet to be determined, states that the present value of their transfer payments, $\Sigma d^t(\tau^t - \mu^t)$, must equal the present value of the net revenues earned on the distorting taxes and subsidies they impose.

The other branch of government, the central bank, controls the money stock or pegs the exchange rate through the use of transfer payments, μ^t, and its holdings of interest-bearing international reserves, b_R^t.[4] The central bank's budget constraint for $t = 1,2, \ldots$ is

$$m_s^t - m_s^{t-1}/(1 + \pi^{t-1}) = \mu^t + b_R^t - (1 + r^{*t-1})b_R^{t-1},$$

which states that the excess of the central bank's transfers and reserve acquisitions, $b_R^t - b_R^{t-1}$, over its interest earnings on its previous reserve holdings, $r^{*t-1}b_R^{t-1}$, must be financed by money creation, $m_s^t - m_s^{t-1}/(1 + \pi^{t-1})$, where m_s^t is the real money supply in period t. When the central bank is pegging the exchange rate rigidly or with preannounced adjustments, it is useful to rewrite their budget constraint as

$$b_R^t = (1 + r^{*t-1})b_R^{t-1} + [m_s^t - m_s^{t-1}/(1 + \pi^{t-1}) - \mu^t], \quad t = 1,2 \ldots . \tag{9}$$

Equation (9) emphasizes that the dynamic behavior of the central bank's international reserve holdings depends on the accumulation of interest on past reserve holdings and flows of reserves through the balance of payments. The balance of payments is the flow demand for real balances, $m_s^t - m_s^{t-1}/(1 + \pi^{t-1})$, less the flow supply of real balances provided by the central bank via its domestic credit operations, μ^t. (Recall that the money stock is demand determined when the central bank pegs the exchange rate.)

Equilibrium in the domestic money market requires that the demand for money equal the supply in each period. As noted earlier, with domestic and foreign inflation rates exceeding the rates dictated by the optimum quantity of money rule, the cash-in-advance constraints will hold with equality. From (5) it follows that, in real terms, the demand for domestic money by domestic residents is $\omega[X^t + p^tZ_s^t(p_s^t)] + (1 - \omega)[X_s^t(p_s^t) + p^tZ^t]$. If foreign residents are solving a similar optimization problem, then their demand for domestic money reflects their demand for imports of domestic goods. Since the goods market must clear in each period, it follows that, in equilibrium, the foreign demand for domestic money equals $\omega[X_s^t(p_s^t) - X^t] + (1 - \omega)p^t[Z_s^t(p_s^t) - Z^t]$. Therefore, the demand for domestic money in period t is simply the value of domestic output at consumer prices, and the money market equilibrium condition can be written as

$$m_s^t = X_s^t(p_s^t) + p^tZ_s^t(p_s^t), \quad t = 1,2, \ldots . \tag{10}$$

Letting $m_s^t = M_s^t/e^tP^{*t}$, where M_s^t is the nominal money stock, it can be seen that under floating rates the money market equilibrium condition determines the equilibrium exchange rate while under a pegged-rate system it determines the equilibrium nominal money stock. From

(9) and (10) it follows that for a given exchange rate policy, $\{e^t = \bar{e}^t\}_{t=1}^{\infty}$, and nominal transfer policy, $\{T^t = \bar{e}^t P^{*t} \bar{\mu}^t\}_{t=1}^{\infty}$, the time path of the central bank's international reserves reflects movements in the balance of payments as determined by the intertemporal behavior of the demand for money.

In addition to the previously discussed budget constraints and market clearing conditions, international trade must balance intertemporally. For the distortion-free case, this can be demonstrated by multiplying the sequence of budget constraints in (4) by the discount factor $d^t = d^{*t} \equiv \Pi_{j=1}^{t-1} (1 + r^{*j})^{-1}$ and summing the resulting expressions. The fact that the cash-in-advance constraints hold with equality can then be used to eliminate the money terms from the resulting equation. Finally, the transfer payment terms can be eliminated by discounting and summing the central bank's budget constraint as given by (9), using (10) in the resulting expression, and noting that in the absence of distorting taxes $\tau^t = \mu^t$. This yields the desired intertemporal trade balance condition ($p_s^t = p^{*t}$ when there are no distortions)

$$(11) \qquad \sum_{t=1}^{\infty} d^{*t}(X^t + p^{*t}Z^t) = \sum_{t=1}^{\infty} d^{*t}[X_s^t(p_s^t) + p^{*t}Z_s^t(p_s^t)].$$

A similar proof, but one involving the fiscal authority's budget constraint, shows that (11) must also hold in the presence of distorting taxes and subsidies.

9.4 Trade Balance Target

Trade balance deficits are commonly viewed with alarm by policymakers and they are not long tolerated before action is taken to eliminate them. One possible explanation for such concerns may be the observed correlation between declines in income and a worsening trade balance that arises as a result of the consumption-smoothing behavior of consumers in response to temporary changes in income. Despite the fact that the resulting correlation between income and the trade balance reflects the optimal response of consumers to exogenous fluctuations in income, if policymakers mistakenly believe causation to be running from the trade balance to income they may perceive there to be some scope for activist policy to improve matters. Although it is apparent that for a distortion-free small open economy the imposition of trade balance targets by the government can only reduce welfare, it is important from an economic standpoint to consider the welfare maximizing structure of taxes and subsidies for attaining trade balance targets when the government deems them to be desirable.

Formally, suppose that the government imposes a sequence of trade balance targets, $\tilde{tb}^t$, for periods $t = 1, \ldots, k$. These constraints require that

$$(12) \quad X_s^t(p_s^t) - X^t + p^{*t}[Z_s^t(p_s^t) - Z^t] \geq \tilde{tb}^t, \quad t = 1, \ldots, k.$$

The optimal policy maximizes the representative agent's lifetime utility as given by (1) subject to the economy's lifetime budget constraint (11) and the sequence of trade balance targets given by (12). Technically, the planning problem confronting the government is to choose $\{X^t\}_{t=1}^{\infty}$, $\{Z^t\}_{t=1}^{\infty}$, and $\{p_s^t\}_{t=1}^{\infty}$ to maximize

$$(13) \quad \sum_{t=1}^{\infty} \rho^{t-1} U(X^t, Z^t) + \lambda \cdot \sum_{t=1}^{\infty} d^{*t}\{X_s^t(p_s^t) - X^t + p^{*t}[Z_s^t(p_s^t) - Z^t]\}$$
$$+ \sum_{t=1}^{k} \theta^t d^{*t}\{X_s^t(p_s^t) - X^t + p^{*t}[Z_s^t(p_s^t) - Z^t] - \tilde{tb}^t\},$$

where λ is the marginal utility of wealth and $\theta^t d^{*t}$ is the marginal welfare loss associated with tightening the period-t trade balance constraint. It should be noted here that the government can manipulate domestic residents' consumption profiles by setting consumption taxes and taxes on international borrowing appropriately.

In addition to the constraints the first-order conditions that emerge from the government's optimization problem given by (13) are[5]

$$(14a) \quad U_Z^t / U_X^t = p^{*t}, \qquad t = 1, 2, \ldots,$$

$$(14b) \quad \frac{-\partial X_s^t / \partial p_s^t}{\partial Z_s^t / \partial p_s^t} = p^{*t}, \qquad t = 1, 2, \ldots,$$

$$(14c) \quad \rho^{t-1} U_X^t / U_X^1 = \begin{cases} d^{*t} \cdot \left[\dfrac{1 + (\theta^t/\lambda)}{1 + (\theta^1/\lambda)}\right], & t = 1, \ldots, k, \\[2ex] d^{*t} \cdot \left[\dfrac{1}{1 + (\theta^1/\lambda)}\right], & t = k + 1, \ldots, \end{cases}$$

where d^{*t} is the world real discount factor for period t.

The first-order conditions (14a) and (14b), in conjunction with the representative agent's first-order conditions (3) and (7), show that the optimal policy calls for setting within-period relative prices confronting consumers and producers equal to world relative prices (i.e., $p^t = p_s^t = p^{*t}$). From (8) and (14c) it is also clear that the optimal policy for attaining a series of trade balance targets entails distorting intertemporal choices. Specifically, in order to induce domestic residents to substitute consumption in the periods after the trade balance targets are lifted for consumption in those periods when they are in effect, international borrowing should be taxed (or equivalent policies introduced) in periods $t = 1, \ldots, k$. Furthermore, taxes on international borrowing should be highest in those periods where the trade balance constraint is most severe (and hence θ^t is greatest). This structure of taxes serves to generate the appropriate intertemporal pattern of substitution by domestic residents.[6] It should be noted here that systems of capital controls and dual exchange rates can replicate the optimal tax structure described by (14). (See Adams and Greenwood [1985] on the equivalence of capital controls and dual exchange rates and Greenwood and Kimbrough [1985] for a look at capital controls and fiscal policy.)

The intuition behind these results is straightforward. The goal of achieving a prespecified sequence of trade balances is essentially aimed at attaining a given intertemporal pattern of consumption (and production in a framework that allows for intertemporal production decisions such as investment in physical capital). It is therefore optimal to enact a tax program that strikes directly at intertemporal relative prices while leaving within-period relative prices undistorted. This rules out tariffs, export subsidies, and other trade policies that strike at within-period relative prices as part of the optimal tax package for achieving trade balance targets.

Earlier it was argued that governments may institute policies designed to achieve a target trade balance because consumption smoothing by consumers results in temporary drops in income worsening the trade balance, and policymakers may view causation as running from the trade balance to income rather than the other way around as is actually the case. In fact, if governments institute trade balance targets when income is temporarily low, the burden of adjusting consumption spending will be concentrated in those periods when income shocks occur rather than being spread over consumers' lifetimes. Enacting trade balance targets in response to temporary income fluctuations thus reduces welfare, relative to the no-intervention benchmark, by preventing consumers from engaging in desirable consumption-smoothing behavior. In fact, enacting such targets can result in an intertemporal consumption pattern that, from the perspective of the permanent-income hypothesis, appears to exhibit excess sensitivity to current income.

9.5 Wealth Target

Another reason countries may undertake policies designed to manipulate the trade balance or current account is a preoccupation with their wealth or net foreign asset position. Such concerns may arise because, as in the case of the mercantilists, changes in a country's wealth are erroneously taken to be indicators of changes in welfare or because policymakers desire to shift the intertemporal pattern of utility, $\{U(X^t,Z^t)\}_{t=1}^{\infty}$.

In order to study the optimal tax policy for achieving a target level of wealth, and to examine its connection with trade balance targets, note that by period k, the country's net foreign asset position will be given by

$$b^k = (1/d^{*k}) \cdot \sum_{t=1}^{k} d^{*t}\{X_s^t(p_s^t) - X^t + p^{*t}[Z_s^t(p_s^t) - Z_t]\}.$$

That is, the country's external wealth by period k is simply the sum of principle and interest earned on its past trade balances. If the government adopts a wealth target of $\bar{b}$ for period k, the problem they face is to maximize

$$\sum_{t=1}^{\infty} \rho^{t-1}U(X^t,Z^t) + \lambda \cdot \sum_{t=1}^{\infty} d^{*t}\{X_s^t(p_s^t) - X^t + p^{*t}[Z_s^t(p_s^t) - Z^t]\}$$
$$+ \theta \cdot (\sum_{t=1}^{k} d^{*t}\{X_s^t(p_s^t) - X^t + p^{*t}[Z_s^t(p_s^t) - Z^t]\} - d^{*k}\bar{b})$$

by choosing the time profiles $\{X^t\}_{t=1}^{\infty}$, $\{Z^t\}_{t=1}^{\infty}$, and $\{p_s^t\}_{t=1}^{\infty}$ where θd^{*k} is the marginal welfare cost of raising the period-k wealth target. It is important to note that when policy is directed toward increasing wealth at world prices, as in the problem being studied here, no attention is given to the distribution of foreign asset holdings between private agents, the fiscal authorities, and the central bank but only to the overall level of wealth, b^k. More will be said about this issue in the following section.

It is easily verified that, in addition to the constraints, the first-order conditions for the government's problem are

(15a) $$U_Z^t/U_X^t = p^{*t}, \qquad t = 1, 2, \ldots,$$

(15b) $$\frac{-\partial X_s^t/\partial p_s^t}{\partial Z_s^t/\partial p_s^t} = p^{*t}, \qquad t = 1, 2, \ldots,$$

(15c) $$\rho^{t-1}U_X^t/U_X^1 = \begin{cases} d^{*t}, & t = 1, \ldots, k, \\ d^{*t} \cdot \left[\dfrac{1}{1 + (\theta/\lambda)}\right], & t = k + 1, \ldots. \end{cases}$$

From (15a) and (15b) it follows immediately that, as was the case with a trade balance target, the optimal attainment of a wealth target does not call for introducing any within-period distortions; the marginal rate of substitution and the marginal rate of transformation between goods at a point in time should both be set equal to world relative prices (i.e., $p^t = p_s^t = p^{*t}$). However, from (15c) it can be seen that, again as was the case with a trade balance target, a wealth target is best attained by taxing international borrowing in periods $t = 1, \ldots, k$. The intuition again is the same: taxing international borrowing in the periods prior to the date when the wealth target is to be met discourages consumption and encourages saving and wealth accumulation. Although the overall character of the optimal tax policies for attaining balance of trade and wealth targets are very similar, there is one key difference: When the government imposes a wealth target, tax rates on international borrowing should be equated in all periods $t = 1, \ldots, k$. This reflects the optimality, from a welfare standpoint, of spreading the burden of attaining the wealth target evenly across periods $t = 1, \ldots, k$. However, with balance of trade targets applying to periods $t = 1, \ldots, k$, taxes on international borrowing will generally differ across periods in a rather complicated way. This means that if policymakers are concerned with increasing wealth, it is inefficient to attempt to do so by imposing a sequence of trade balance targets on the economy. The reason is that by instituting a system of trade balance targets that will produce the target wealth level, the government, generally speaking, imposes an unnecessary constraint on the intertemporal pattern of wealth accumulation that can only reduce welfare. Finally, note that the example of policies aimed at attaining a target wealth level highlights the distinction between wealth and welfare. It is straightforward to show that with a target wealth level of $\bar{b}$ applying to period k, welfare evaluated from period $k + 1$ on is higher than it would have been in the absence of a wealth target. This follows from the fact that the consumer's indirect utility function from period $k + 1$ on is an increasing, concave function in period-k wealth. However, from the perspective of period one, when the wealth target is introduced, agents' lifetime welfare is clearly reduced. That is, the government's policy of enacting taxes to increase wealth, even when optimally carried out, actually reduces welfare. (A related point has been made by Murphy [1985] regarding the impact of tariffs on the time profile of agents' utilities.)

9.6 International Reserve Target

Oftentimes countries that have adopted a fixed exchange rate or a crawling peg find confidence in the exchange rate being undermined by an impending balance of payments crisis. Such crises typically involve a situation in which the central bank's holdings of international reserves have dwindled to so low a level that a speculative attack threatens to deplete the remaining stock. One way to forestall such an attack is to implement a comprehensive package of monetary and fiscal reforms that promises to augment the central bank's reserve holdings through a sustained period of balance of payments surpluses. A key ingredient of such policy reforms is to reduce domestic credit creation, T^t, or to devalue the domestic currency. In the context of the model being used here, these policies would be reflected by a drop in μ^t which would trigger an improvement in the balance of payments, $m_s^t - m_s^{t-1}/(1 + \pi^{t-1}) - \mu^t$, and a buildup of international reserves, b_R^t, by the central bank.

In models similar to the one being used here it has been shown (e.g., Helpman [1981], Lucas [1982], and Stockman [1983]) that exchange rate management policies have no real effects. This result is an open economy implication of Ricardian equivalence. Therefore, under debt neutrality, when policymakers wish to defend the exchange rate by building up the central bank's stock of international reserves to some target level, the first-best policy always involves adjusting the time-path of domestic credit.[7] However, for whatever reasons, countries do not always adjust their domestic credit policies sufficiently, and some of the burden of adjusting the economy to the exchange rate ultimately falls on fiscal policy. This section of the paper examines the optimal tax policy, in the fiscal sense, for achieving a target level of international reserves. The following section takes up the closely related issue of the optimal tax policy for achieving a balance of payments target. It should be borne in mind that in both cases the tax policies being discussed are second-best for the noneconomic objective under consideration; the first-best policy in both instances would be to alter the central bank's real transfer sequence, $\{\mu^t\}_{t=1}^{\infty}$, by changing the time-path of domestic credit. This would directly affect the balance of payments and the central bank's international reserve holdings without creating welfare reducing distortions.

9.6.1 The Government's Optimization Problem

Suppose that the government desires to build the central bank's stock of international reserves up to the target level $\bar{b}_R$ by the end of period k. By repeated substitution using the central bank's budget constraint, (9), it can be shown that period-k reserve holdings will be

$$\begin{aligned} b_R^k &= (1/d^{*k}) \cdot \sum_{t=1}^{k} d^{*t}[m_s^t - m_s^{t-1}/(1 + \pi^{t-1}) - \mu^t] \\ &= (1/d^{*k}) \cdot \left[d^{*k}(m_s^k - \mu_s^k) + \sum_{t=1}^{k-1} d^{*t}\left(\frac{i^t m_s^t}{1 + i^t} - \mu^t\right)\right], \end{aligned}$$

where $(1 + i^t) \equiv (1 + \pi^t)(1 + r^{*t})$ implicitly defines the domestic nominal interest rate, i^t. Recall that arbitrage in the market for good X implies that $1 + \pi^t = (1 + \epsilon^t)(+ \pi^{*t})$, where $\epsilon^t = (e^{t+1} - e^t)/e^t$ is the policy determined rate of depreciation of the domestic currency.

Therefore, it follows that the interest parity condition $1 + i^t = (1 + \epsilon^t)(1 + i^{*t})$ holds, where $i^{*t} \equiv r^{*t} + \pi^{*t} + r^{*t}\pi^{*t}$ is the foreign nominal interest rate. It should be noted here that i^t, which is exogenously determined by world market conditions and domestic policy, is actually the domestic nominal interest rate prior to accounting for any wedge driven between domestic and foreign real interest rates by domestic tax policy. However, this is the nominal interest rate that is relevant for calculating the inflation tax revenues earned by the central bank through the accumulation of interest-bearing international reserves.

Since the international reserve target requires that the central bank's period-k reserves, as given above, meet or exceed $\bar{b}_R$, and since the money supply is demand determined under pegged rates according to (10), the planning problem confronting the government is to choose time profiles for X^t, Z^t, and p_s^t that maximize[8]

$$(16) \quad \sum_{t=1}^{\infty} \rho^{t-1} U(X^t, Z^t) + \lambda \cdot \sum_{t=1}^{\infty} d^{*t}\{X_s^t(p_s^t) - X^t + p^{*t}[Z_s^t(p_s^t) - Z^t]\}$$
$$+ \alpha \cdot \left(\sum_{t=1}^{k-1} d^{*t} \left\{ \frac{i^t[X_s^t(p_s^t) + (U_Z^t/U_X^t)Z_s^t(p_s^t)]}{1 + i^t} - \mu^t \right\} \right.$$
$$\left. + d^{*t}[X_s^k(p_s^k) + (U_Z^k/U_X^k)Z_s^k p_s^k) - \mu^k - \bar{b}_R] \right),$$

where use has been made of the fact that optimization on the part of private agent's imposes (7) as an incentive compatibility condition. (It can be seen immediately from [16] that by adjusting $\{\mu^t\}_{t=1}^k$ the target can be hit at no cost.)

With some manipulation it can be shown that the first-order conditions for the government's problem yield the following tangency conditions (i^t has been taken to be constant to simplify the notation):

$$(17a) \quad U_Z^t/U_X^t = \begin{cases} \dfrac{p^{*t} + \theta^t(i/1 + i)s_X^t}{1 - \theta^t(i/1 + i)s_Z^t}, & t = 1, \ldots, k-1, \\[2ex] \dfrac{p^{*t} + \theta^t s_X^t}{1 - \theta^t s_Z^t}, & t = k, \\[2ex] p^{*t}, & t = k+1, \ldots, \end{cases}$$

$$(17b) \quad \frac{-\partial X_s^t/\partial p_s^t}{\partial Z_s^t/\partial p_s^t} = \begin{cases} \dfrac{\lambda p^{*t} + \alpha(i/1 + i)p^t}{\lambda + \alpha(i/1 + i)}, & t = 1, \ldots, k-1, \\[2ex] \dfrac{\lambda p^{*t} + \alpha p^t}{\lambda + \alpha}, & t = k, \\[2ex] p^{*t}, & t = k+1, \ldots, \end{cases}$$

$$(17c) \quad \rho^{t-1}U_X^t/U_X^1 = \begin{cases} d^{*t}\cdot\dfrac{1-\theta^t(i/1+i)s_Z^t}{1-\theta^1(i/1+i)s_Z^1}, & t=1,\ldots,k-1\,, \\ d^{*t}\cdot\dfrac{1-\theta^t s_Z^t}{1-\theta^1(i/1+i)s_Z^1}, & t=k\,, \\ d^{*t}\cdot\dfrac{1}{1-\theta^1(i/1+i)s_Z^1}, & t=k+1,\ldots, \end{cases}$$

where

$$\theta^t = \alpha Z_s^t H^t/\lambda U_X^t,\ H^t = 2p^tU_{XZ}^t - U_{ZZ}^t - (p^t)^2U_{XX}^t > 0\,,$$
$$s_X^t = (p^tU_{XZ}^t - U_{ZZ}^t)/H^t > 0\,,$$

and

$$s_Z^t = (U_{ZX}^t - p^tU_{XX}^t)/H^t > 0\,.$$

The term $s_j^t, j = X,Z$, is the marginal change in an agent's purchases of good j when the expenditure allocated to period t changes. It follows from the within-period budget constraint that $s_X^t + p^ts_Z^t = 1$.

9.6.2 Interpretation

To begin with, note from the agent's first-order condition (7) and the first-order condition (17a) that given the international reserve target the optimum tax on consumption of good Z can be calculated as

$$\eta^t = \begin{cases} \dfrac{(\theta^t/p^{*t})(i/1+i)}{1-\theta^t(i/1+i)s_Z^t}, & t=1,\ldots,k-1\,, \\ \dfrac{\theta^t/p^{*t}}{1-\theta^ts_Z^t}, & t=k\,, \\ 0\,, & t=k+1,\ldots, \end{cases}$$

where η^t satisfies $U_Z^t/U_X^t = p^t = (1+\eta^t)p^{*t}$. The first thing to notice is that the optimal policy calls for no within-period taxes on consumption after the "deadline" period, period k. In interpreting the tax rates for periods $t = 1, \ldots, k$ it is useful to consider as a benchmark the case where the initial distortion-free equilibrium is a steady-state so that p^{*t}, θ^t, s_X^t, and s_Z^t are constant across periods. In this case it is readily seen that the optimal tax structure involves levying a consumption tax on good Z that is constant up until the deadline period and then raising the consumption tax to a higher level in period k when the reserve target must be fulfilled. In fact, the period-k consumption tax rate is somewhat greater than $(1+i)/i$ times that in the earlier periods. For typical values of the nominal interest rate it follows that the optimal consumption tax in period k may be several times that for periods $t = 1, \ldots, k-1$.

The intuition behind these results is as follows: As can be seen from (10), enacting a consumption tax raises the demand for money and, given the central bank's domestic credit policy μ^t, improves the balance of payments and leads to an inflow of international reserves. During periods $1, \ldots, k - 1$ the central bank accumulates reserves from increments to money demand at a rate equal to the interest earned on its inflation tax revenues of $i/(1 + i)$. This follows from the fact that while a consumption tax levied in period t improves the balance of payments in period t by $p^{*t}Z_s^t d\eta^t$, it raises agents' initial levels of real balance at the start of period $t + 1$ and thus worsens the balance of payments in period $t + 1$ by $p^{*t}Z_s^t d\eta^t/(1 + \pi^t)$. Therefore, in period t present-value terms, a consumption tax levied then adds $ip^{*t}Z_s^t d\eta^t/(1 + i)$ to the central bank's international reserves. Since the latter influence is not explicitly accounted for during the deadline period, period k, consumption taxes levied then contribute $p^{*k}Z_s^k d\eta^k$ toward the reserve target. It is thus optimal to tax consumption most heavily in period k. Finally, it can be seen that, all else equal, consumption taxes should be relatively low in periods where world relative prices, p^{*t}, are relatively high. This pattern of taxation serves to smooth fluctuations in domestic relative prices facing consumers, $p^t = (1 + \eta^t)p^{*t}$.

Returning to the benchmark steady-state case, it can be seen from (17c) that the intertemporal taxes called for by the optimal plan serve to mitigate the welfare-reducing effects of the within-period consumption taxes that were just discussed. To see this, note first that no intertemporal distortions are introduced between any two periods t and $t + j$ after the deadline period. However, the government's intertemporal taxes act to subsidize international borrowing in periods $1, \ldots, k$.[9] This serves to reallocate consumption from the later periods, where consumers' within-period marginal rates of substitution equal world relative prices, to the earlier periods, where consumption taxes have raised consumers' marginal rates of substitution above world relative prices so that a welfare gain of $\rho^{t-1}U_X^t\eta^t p^{*t}$ attaches to increases in the consumption of good Z. Additionally, given the initial equilibrium was a steady state, it can be seen that agents' intertemporal choices between periods $t = 1, \ldots k - 1$ are left undistorted and hence are all taxed relative to period k. Since all periods $t = 1, \ldots, k$ are subsidized relative to the later periods, it follows that international borrowing is subsidized equally in periods prior to period k (in which consumption taxes are equal) and subsidized at a higher rate in period k (when the consumption tax is the highest).

Equation (17b) characterizes the optimum structure of production taxes. Recalling the competitive profit maximizing condition (3), and using the condition $p^t = (1 + \eta^t)p^{*t}$, it can be demonstrated that the optimal policy calls for the production of good Z to be subsidized at the rate

$$\eta_s^t = \begin{cases} \dfrac{\alpha(i/1 + i)\eta^t}{\lambda + \alpha(i/1 + i)}, & t = 1, \ldots, k - 1, \\ \dfrac{\alpha\eta^t}{\lambda + \alpha}, & t = k, \\ 0, & t = k + 1, \ldots, \end{cases}$$

where $p_s^t = (1 + \eta_s^t)p^{*t}$. As was the case for consumption decisions, production decisions are left undistorted after period k. Production is subsidized from the current period through period k, with the subsidy remaining constant until period k when it is increased. The explanation for the intertemporal pattern of production subsidies is the same as that outlined earlier for the intertemporal pattern of consumption taxes. The optimal policy calls for subsidies to good Z production because this raises the demand for money and augments the buildup of reserves. Both consumption taxes and production subsidies work in this direction, and it is optimal to distort both decisions until their marginal welfare costs are equal. However, it is readily apparent that this occurs when production subsidies are lower than consumption taxes (i.e., when $\eta_s^t \leq \eta^t$). The reason for this is that since agent's trading opportunities are constrained by the intertemporal budget constraint (11), it is optimal to minimize as much as possible the reduction in the value of domestic output at world prices that is generated by distorting production decisions.

Finally, unlike the optimal policy for a trade balance target, the optimal policy for an international reserve target does, in essence, entail levying tariffs, export subsidies, or equivalent trade distortions that divert within-period domestic relative prices from their world level. This follows from the well-known result that imposing a consumption tax and a production subsidy on importables (exportables) at equal rates is equivalent to imposing a tariff (export subsidy) at that rate. Therefore, from the preceding discussion, it is apparent that the optimal policy for a reserve target can be structured to include tariffs at the rate η_s^t plus additional consumption taxes on good Z at the rate $(\eta^t - \eta_s^t)/(1 + \eta_s^t)$ during those periods when good Z is imported and export subsidies and consumption taxes on good Z at the rates η_s^t and $(\eta^t - \eta_s^t)/(1 + \eta_s^t)$ during those periods when good Z is exported.

At this point it is worth reemphasizing that the first-best policy for building up international reserves is to devalue or reduce the rate of growth of domestic credit. However, neither of these policies have real effects, and they thus alter only the composition of the economy's wealth between private holdings of foreign assets and central bank holdings of international reserves rather than the overall level of wealth. In contrast, the set of taxes outlined above does alter the economy's overall level of wealth. If the policymaker's objective is to attain a target wealth level, it is easy to see by comparing the tax policies implicit in (15) and (17) that international reserve targets are not the welfare maximizing policy.[10] Intuitively, the reason is that instituting international reserve targets imposes a constraint on the distribution of wealth between the private sector, the fiscal authorities, and the central bank that is unnecessary when the goal is simply to accumulate wealth (devaluation or reductions of domestic credit growth can be used to build up international reserves but not wealth). Alternatively, if the distribution of wealth is itself the goal, devaluation or changes in domestic credit are the optimal policy since neither lowers welfare as do the tax policies described by (17). The upshot is that while policymakers worldwide are constantly preoccupied with the level of their central bank's international reserves, tax policies designed with such targets in mind will not generally be optimal from the perspective of wealth accumulation or distribution despite the fact that international reserves held by the central bank do constitute part of a country's wealth.

9.7 Balance of Payments Target

The last section was concerned with a case where the government has a target level of international reserves for period k and allows the balance of payments to adjust optimally to attain this target. An alternative, and generally inferior, policy for building up reserves to support the exchange rate is to impose a sequence of constraints on the balance of payments that assures reserve holdings will reach the target level at the appropriate time. Such balance of payments targets may be imposed either directly by the domestic government or by the domestic government at the behest of international creditors.

9.7.1 The Government's Optimization Problem

To find the optimal tax policy in this instance, note that the sequence of balance of payments targets, $\{\tilde{bp}^t\}_{t=1}^k$, requires that

$$m_s^t - m_s^{t-1}/(1 + \pi^{t-1}) - \mu^t \geq \tilde{bp}^t\,, \quad t = 1, \ldots, k\,.$$

The government's problem is thus to choose $\{X^t\}_{t=1}^{\infty}$, $\{Z^t\}_{t=1}^{\infty}$, and $\{p_s^t\}_{t=1}^{\infty}$ so as to maximize[11]

$$(18) \quad \sum_{t=1}^{\infty} \rho^{t-1} U(X^t, Z^t) + \lambda \cdot \sum_{t=1}^{\infty} d^{*t}\{X_s^t(p_s^t) - X^t$$

$$+ p^{*t}[Z_s^t(p_s^t) - Z^t]\}$$

$$+ \sum_{t=1}^{k} \alpha^t d^{*t}[X_s^t(p_s^t) + (U_Z^t/U_X^t)Z_s^t(p_s^t)$$

$$- \frac{X_s^{t-1}(p_s^{t-1}) + (U_Z^{t-1}/U_X^{t-1})Z_s^{t-1}(p_s^{t-1})}{1 + \pi^{t-1}}$$

$$- \mu^t - \bar{b}p^t] .$$

In addition to the constraints the first-order conditions for (18) are (again i^t is taken to be constant to simplify the notation)

$$\text{(19a)} \qquad U_Z^t/U_X^t = \begin{cases} \dfrac{p^{*t} + \delta^t\left(\alpha^t - \dfrac{\alpha^{t+1}}{1+i}\right)s_X^t}{1 - \delta^t\left(\alpha^t - \dfrac{\alpha^{t+1}}{1+i}\right)s_Z^t}, & t = 1, \ldots, k-1, \\[2ex] \dfrac{p^{*t} + \delta^t\alpha^t s_X^t}{1 - \delta^t \alpha^t s_Z^t}, & t = k, \\[2ex] p^{*t}, & t = k+1, \ldots, \end{cases}$$

$$\text{(19b)} \qquad \frac{-\partial X_s^t/\partial p_s^t}{\partial Z_s^t/\partial p_s^t} = \begin{cases} \dfrac{\lambda p^{*t} + \left(\alpha^t - \dfrac{\alpha^{t+1}}{1+i}\right)p^t}{\lambda + \left(\alpha^t - \dfrac{\alpha^{t+1}}{1+i}\right)}, & t = 1, \ldots, k-1, \\[2ex] \dfrac{\lambda p^{*t} + \alpha^t p^t}{\lambda + \alpha^t}, & t = k, \\[2ex] p^{*t}, & t = k+1, \ldots, \end{cases}$$

$$\text{(19c)} \quad \rho^{t-1}U_X^t/U_X^1 = \begin{cases} d^{*t} \cdot \dfrac{1 - \delta^t\left(\alpha^t - \dfrac{\alpha^{t+1}}{1+i}\right)s_Z^t}{1 - \delta^1\left(\alpha^1 - \dfrac{\alpha^2}{1+i}\right)s_Z^1}, & t = 1, \ldots, k-1 \\[2ex] d^{*t} \cdot \dfrac{1 - \delta^t \alpha^t s_Z^t}{1 - \delta^1\left(\alpha^1 - \dfrac{\alpha^2}{1+i}\right)s_Z^1}, & t = k, \\[2ex] d^{*t} \cdot \dfrac{1}{1 - \delta^1\left(\alpha^1 - \dfrac{\alpha^2}{1+i}\right)s_Z^1}, & t = k+1, \ldots, \end{cases}$$

where $\delta^t = Z_s^t H^t / \lambda U_X^t$.

9.7.2 Interpretation

In conjunction with (7) it can be seen from (19a) that the optimal structure of taxes and subsidies on the consumption of good Z satisfies

$$\eta^t = \begin{cases} \dfrac{(\delta^t/p^{*t})\left(\alpha^t - \dfrac{\alpha^{t+1}}{1+i}\right)}{1 - \delta^t\left(\alpha^t - \dfrac{\alpha^{t+1}}{1+i}\right)s_Z^t}\,, & t = 1, \ldots, k-1\,, \\ \dfrac{(\delta^t/p^{*t})\alpha^t}{1 - \delta^t\alpha^t s_Z^t}\,, & t = k\,, \\ 0\,, & t = k+1, \ldots\,. \end{cases}$$

Several features of the optimal policy are readily apparent. First, within-period consumption choices should be left undistorted in those periods with no balance of payments objectives ($t = k + 1, \ldots$). Second, during those periods where the government has set balance of payments targets, consumption of good Z in period t should be taxed or subsidized as the shadow value of an exogenous increase in period-t money demand, $\alpha^t - \alpha^{t+1}/(1 + i)$, is positive or negative. Intuitively, when the shadow value of real balances is positive (negative) a tax (subsidy) on the consumption of good Z is called for to raise (lower) the demand for money. To see that $\alpha^t - \alpha^{t+1}/(1 + i)$ can be interpreted as the shadow value of an exogenous increase in the demand for money, note that a one-unit exogenous increase in period t money demand raises current utility by $\alpha^t d^{*t}$, since less reliance on period t distortions is called for to meet the balance of payments target. However, this means greater distortions in period $t + 1$ are called for to meet the balance of payments target then. These added distortions reduce current utility by $\alpha^{t+1}d^{*t+1}/(1 + \pi^t)$. Therefore, in terms of current utility the marginal benefit of an exogenous increase in the period-t demand for money is

$$\alpha^t d^{*t} - \alpha^{t+1}d^{*t+1}/(1 + \pi^t) = d^{*t}\left[\alpha^t - \frac{\alpha^{t+1}}{1+i}\right].$$

The term in brackets thus measures the shadow value, as of period t, of exogenous increments to money demand. (Note that period k is a special case of this argument where $\alpha^{k+1} \equiv 0$.)

The exact intertemporal pattern of consumption taxes, η^t, will depend on (i) the sequence of balance of payments targets, $\{\tilde{bp}^t\}_{t=1}^{\infty}$, and (ii) the time-path of nominal domestic credit and the exchange rate as reflected in the real transfer sequence, $\{\mu^t\}_{t=1}^{\infty}$. For purposes of illustration, suppose the economy is initially in a steady state with a constant real transfer sequence, $\mu^t = \mu \; \forall \; t$, and a uniform balance of payments target, $\tilde{bp}^t = \tilde{bp} \; \forall \; t = 1, \ldots, k$.[12] In this case it is easily shown using the balance of payments constraint that the consumption tax on good Z must rise over time. That is, the optimal policy entails $\eta^k > \eta^{k-1} > \ldots > \eta^1 > 0$. The reason for this is that as each successive balance of payments constraint is met, agents' beginning-of-period real balances get higher and higher. In order to generate a constant excess flow demand for money, the demand for money must be pushed higher and higher via increases in consumption taxes. In general, when compared with this benchmark case, those periods with larger (smaller) real transfers and more (less) ambitious balance of payments objectives will have their consumption taxes raised (lowered).

The optimal structure of production subsidies and taxes on good Z can be obtained from (19b). Recalling that $p^t = (1 + \eta^t)p^{*t}$ and using (3) it can be shown that

$$\eta_s^t = \begin{cases} \dfrac{\left(\alpha^t - \dfrac{\alpha^{t+1}}{1+i}\right)\eta^t}{\lambda + \left(\alpha^t - \dfrac{\alpha^{t+1}}{1+i}\right)}, & t = 1, \ldots, k-1, \\ \dfrac{\alpha^t \eta^t}{\lambda + \alpha^t}, & t = k, \\ 0, & t = k+1, \ldots . \end{cases}$$

As was the case for consumption, production decisions should be left undistorted in those periods where there is no balance of payments target. In all periods where there is a balance of payments target, the production of good Z should be subsidized. The rationale behind this is that regardless of the shadow value of additional money demand, $\alpha^t - \alpha^{t+1}/(1 + i)$, a production subsidy moves money demand, the value of domestic output at consumer prices, in the appropriate direction. This is illustrated in figure 1 for the case $\alpha^t - \alpha^{t+1}/(1 + i) > 0$ where period-t consumption is taxed because increases in money demand are desirable and in figure 2 for the case $\alpha^t - \alpha^{t+1}/(1 + i) < 0$ where the opposite is true. In both cases the production equilibrium is at A before and at B after the production subsidy is implemented. As can be seen, in both instances the production subsidy moves the value of domestic output at consumer prices in the correct direction as shown by the shift of the p^t line as production shifts from A to B. Third, note that once again the optimal policy calls for production distortions, η_s^t, to be less in absolute terms than consumption distortions, η^t. Finally, in the benchmark case discussed earlier the optimum production subsidy will rise over time (i.e., $\eta_s^k > \eta_s^{k-1} > \ldots > \eta_s^1 > 0$).

Turning next to the optimal structure of taxes and subsidies on international borrowing, consider equation (19c). Between periods without balance of payments targets no distortions should be introduced

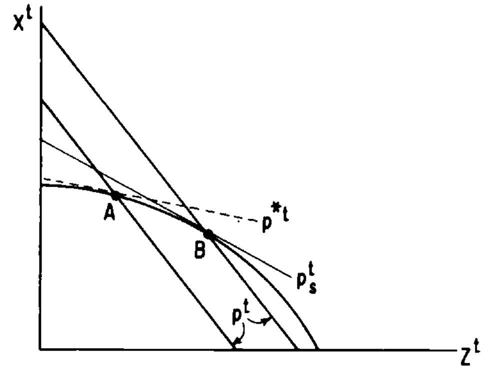

Fig. 9.1 $\alpha^t - \alpha^{t+1}/(1+i) > 0$

into agents' intertemporal consumption pattern. For the periods with balance of payments targets, international borrowing should be subsidized or taxed as the shadow value of money demand, $\alpha^t - \alpha^{t+1}/(1 + i)$, is positive or negative.[13] The intertemporal substitution effects that this pattern of taxes and subsidies generates act to minimize the welfare cost of attaining the balance of payments objectives by shifting agents' consumption profiles towards those periods where consumption of good Z is taxed, and hence $U_Z^t/U_X^t > p^{*t}$, and away from those periods where consumption of good Z is subsidized, and hence $U_Z^t/U_X^t < p^{*t}$. In the benchmark case the optimal policy calls for a rising subsidy to international borrowing throughout the period of balance of payments targets. This reflects the need to mitigate the welfare costs imposed on the economy by the rising consumption tax levied on good Z.

In comparing the case where the government imposes a balance of payments target on the economy for k periods, perhaps with some ultimate reserve target in mind, with that where it has an international reserve target for period k but allows the intertemporal pattern of the balance of payments to adjust optimally, it should be noted that the first-order conditions for the former problem are equivalent to those for the latter when α^t, the marginal cost of tightening the balance of payments constraint, is constant across periods (i.e., when $\alpha^1 = \ldots = \alpha^k$). Therefore, for a given real transfer sequence $\{\eta^t\}_{t=1}^k$, if the sequence of balance of payments targets, $\{\bar{bp}^t\}_{t=1}^k$, is properly chosen the strategy of imposing a sequence of balance of payments constraints can replicate the optimal policy for achieving a target reserve level, $\bar{b}_R$. However, if the ultimate goal is to build the central bank's stock of international reserves up to some desired level, then attempting to accomplish this by instituting some arbitrary sequence of balance of payments targets will not be optimal—the constraint on the time profile

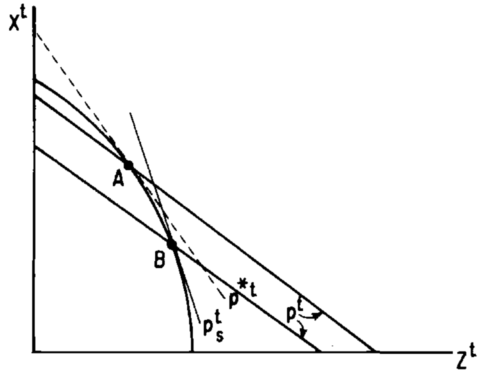

Fig. 9.2 $\alpha^t - \alpha^{t-1}/(1+i) < 0$

of the balance of payments is an extra constraint on the economy and can only reduce welfare more than is necessary in order to attain the reserve target.

9.8 Conclusion

This paper has outlined an extended version of the traditional two-sector model of international trade and public finance that incorporates intertemporal consumption choices and monetary considerations. The resulting framework was used to examine the optimal tax policies associated with various noneconomic objectives relating to the balance of payments accounts. First, the optimal policy for achieving a trade balance objective was considered. This policy was shown to involve levying taxes on international borrowing (or equivalent policies) so as to shift consumption away from those periods where an improved trade balance is deemed desirable. It was also shown that the optimal policy for reaching a trade balance target leaves intact the within-period efficiency conditions $U^t_Z/U^t_X = p^{*t} = (-\partial X^t_s/\partial p^t_s)/(\partial Z^t_s/\partial p^t_s)$. Therefore, trade balance goals do not call for instituting tariffs or export subsidies that drive a wedge between world and domestic relative prices. The optimal policy for a trade balance objective was then compared with the optimal policy for achieving a wealth target. It was demonstrated that the two policies differ, because while a wealth target calls for enacting a time invariant tax rate on international borrowing, the optimal attainment of a trade balance target generally speaking entails a time varying tax rate on international borrowing.

An international reserve target was the next policy for which the optimal structure of taxation was derived. Starting from a distortion-free, steady-state equilibrium, and given a precommitment to certain domestic credit and exchange rate policies, it was shown that the optimal tax structure entails consumption taxes, production subsidies, and subsidies to international borrowing that are constant across periods until the reserve target is to be met, and then raised, perhaps substantially, when the day of reckoning arrives. After this period all distortions should be dismantled. It was also pointed out that the within-period distortions introduced by the optimal policy can be structured to include tariffs and export subsidies.

The fourth, and final, objective for which the optimal tax policy was constructed was a sequence of balance of payments targets. Under the conditions outlined above, and assuming a constant balance of payments objective, the optimal policy was demonstrated to consist of rising consumption taxes and production subsidies as well as rising subsidies to international borrowing throughout the period of balance of payments goals. Again, it was also argued that all distortions should be immediately dismantled after this time. Although not pointed out in the text, it should be apparent that in this instance the optimal policy's within-period distortions can again be replicated by a system of tariffs and export subsidies (accompanied with additional consumption taxes or subsidies as well).

Some interesting results emerge from comparing the optimal tax structures for the four noneconomic objectives that were investigated here. First, while international reserve targets and balance of payments targets are obviously closely related, the optimum tax policies for the two goals differ significantly. This is because the latter policy is aimed at attaining a certain intertemporal behavior for the balance of payments while from the perspective of the former policy such behavior is largely irrelevant. Second, although it is apparent from the balance of payments accounting identities that improving the trade balance is one way to achieve an international reserve target or a balance of payments goal, it is clear that the optimal policies for these objectives differ dramatically. The goals of an improved balance of payments and a reserve target can both be optimally accomplished, given domestic credit and exchange rate policies, via a policy that includes tariffs, export subsidies, and other within-period distortions. However, such distortions and trade impediments are not part of the optimal tax mix for improving the trade balance. An improved trade balance calls for a system of taxes on international borrowing (or equivalent policies). This is in stark contrast to the system of subsidies to international borrowing required by a reserve target and, at least during some periods, by a balance of payments target.[14] Finally, it was argued that international reserve targets cannot be justified (i.e., are not first-best) if the policymaker's goal is to attain a target level of wealth or a given distribution of wealth between the private sector, the fiscal authorities, and the central bank. If the goal is a target wealth level, a constant tax rate on international borrowing should be levied (until the deadline period) and no within-period distortions should be introduced, while if the objective is to alter the composition of net foreign asset holdings, shifts in the time profiles of domestic credit and the exchange rate are appropriate.

A number of extensions and implications of the analysis of optimal policies undertaken here suggest themselves. To the extent that trade barriers are erected and torn down because of noneconomic objectives like the ones considered here, the public-finance-type approach that has been adopted can be used to study the optimal sequencing of economic liberalizations. Capturing important aspects of the liberalization process might entail extending the model to include sector-specific capital or other features giving rise to dynamics on the production side of the economy, but the approach is, in principle, capable of dealing with these and other issues.

Another possible extension concerns the use of the cash-in-advance constraint to model money. It might be useful to model money in a way that allows the velocity of money to vary with nominal interest rates. This could be done by using the transactions technology employed by Adams and Greenwood (1985) or by adopting the variant of the cash-in-advance approach suggested by Svensson (1985). Either extension would give money real effects, essentially through an inflation tax channel, thereby potentially allowing for a more elaborate interaction between monetary and fiscal policies. In the current framework the interaction between monetary and fiscal policies is limited to the impact of domestic inflation on the slopes of the tax rate time profiles. For example, with an international reserve target the slope of the consumption tax profile is adequately summarized by the ratio η^k/η^t, $t = 1, \ldots, k - 1$, in the steady-state case. As can be seen from the results outlined in section 9.6, when the initial equilibrium is a steady state, η^k/η^t is directly related to $(1 + i)/i$. Therefore, the higher the domestic inflation rate, and hence the higher the domestic nominal interest rate, the flatter the time profile of consumption tax rates. Intuitively, as domestic inflation approaches the rate dictated by the optimum quantity of money rule, and hence the domestic nominal interest rate approaches zero, the building up of reserves through the accumulation of inflation tax revenues diminishes. As a consequence, an increasing reliance on consumption taxes to raise money demand during the deadline period is necessitated. Thus as domestic inflation falls toward the optimum quantity of money rate the consumption tax profile gets steeper. Similarly, the production and international borrowing subsidy profiles under a reserve target also get steeper when domestic inflation is reduced.

One final extension would be to allow for intertemporal decisions on the production side of the economy. This could be done along the lines suggested by Aschauer and Greenwood (1983) or by Helpman and Razin (1984). These extensions would also result in money being nonneutral and potentially allow for a richer interaction between monetary and fiscal policies.

Extending the model along the lines suggested above to allow for variable velocity, real effects of inflation, and factor supply decisions can easily be accomplished by introducing leisure into the consumer's utility function and assuming that domestic (foreign) money serves to economize on time spent transacting in domestic (foreign) markets.[15] In this case the optimal policies for trade balance and wealth targets remain the same as outlined in sections 9.4 and 9.5 with the additional proviso that domestic monetary policy should be guided by the optimum quantity of money rule, and interest should be paid on domestic holdings of foreign currency if the optimum quantity of money rule is not being followed abroad. The optimal policies for international reserve and balance of payments targets are more difficult to characterize. At first, such goals seem to call for departing from the optimum quantity of money rule by pursuing policies that generate a real rate of return on domestic money in excess of that on internationally traded bonds (the goal being to stimulate the demand for domestic money). However, equilibria with this characteristic may be problematic. Further research into the link between the monetary mechanism of exchange and the optimal policies for international reserve targets and balance of payments goals thus seems warranted.

Notes

1. For a thorough survey of the literature see Dixit (1985).
2. As will become apparent shortly, since factor supplies are taken to be inelastic in the traditional two-sector model, Helpman's result that the economy's real equilbirium duplicates that of a costless barter economy survives this extension to a production economy. See Aschauer and Greenwood (1983) and Helpman and Razin (1984) for examples in which, because of less than perfectly inelastic factor supplies, the monetary economy's real equilibrium fails to replicate that of a costless barter economy.
3. See Helpman and Razin (1984) for a discussion of alternative monetary mechanisms.
4. As noted by Helpman (1981), by holding interest-bearing reserves the central bank minimizes its operating costs. For a discussion of the implications of interest-bearing versus non-interest-bearing reserves see Persson (1984).
5. This problem has been considered elsewhere by Greenwood and Kimbrough (1987) in a two-period setup similar to the one used here and by Dasgupta and Stiglitz (1974) in a barter economy with public production and non-

traded goods. In both of these papers the constraint (12) holds only for a single period.

6. To see these results a bit more clearly, it may help to rewrite (14c) as

$$\rho^{t-1}U_X^t/\rho^{N-1}U_X^N = (d^{*t}/d^{*N})[1 + (\theta^t/\lambda)] ,$$

where $\theta^t \equiv 0$ for $t = k + 1, \ldots$ and N is some arbitrary period after period k. It follows that the optimum tax on international borrowing in period t is θ^t/λ.

7. For a model in which this would not necessarily be the only component of the first-best policy because Ricardian equivalence fails to hold as the result of the uncertain lifetimes of private agents, see Helpman and Razin (1987).

8. From the central bank's budget constraints appearing in (9) it is apparent that the condition $b_R^k \geq \tilde{b}^R$ imposes a constraint not only on the behavior of the balance of payments prior to period k but after period k as well. In particular, it is required that

$$(1/d^{*k}) \cdot \left[\sum_{t=k+1}^{\infty} d^{*t}\left(\mu^t - \frac{i^t m_s^t}{1 + i^t}\right) + d^{*k}m_s^k/(1 + \pi^k)\right] \geq \tilde{b}_R .$$

The analysis presented in the text assumes that this constraint is met by appropriately setting domestic credit and/or the exchange rate, as captured by μ^t, in some distant future period (i.e., as $t \rightarrow \infty$). Alternatively, tax policies like those discussed in the text could be employed. These policies can be derived formally by adding the above as an additional constraint to (16). However, since the policies for periods $t = 1, \ldots, k$ are qualitatively unchanged, this approach has not been adopted in the text. In either case, the important point is that future policies are constrained by today's international reserve objectives.

9. This can be seen by rewriting (17c) as suggested in footnote 6 and noting that the optimal policy calls for subsidizing international borrowing in period t at the rate $\theta^t(i/1 + i)^\gamma s_Z^t$, where $\theta^t \equiv 0$ for $t = k + 1, \ldots$ and $\gamma = 0$ for $t = k$ and $\gamma = 1$ for all other periods.

10. It is possible, in fact, that a country's external wealth, b^k, may actually fall while international reserves are built up to the target level, $\tilde{b}_R$. To see this, note that the policies outlined by (17) reduce income at world prices in periods $t = 1, \ldots, k$. However, consumption smoothing on the part of private agents implies that this burden will be spread over the consumer's entire lifetime so that the trade balance will deteriorate in periods $t = 1, \ldots, k$. Turning to the substitution effects generated by (17), there are two to consider. First, the consumption taxes in periods $t = 1, \ldots, k$ that are instituted to attain the international reserve target raise the relative price of consuming in periods $t = 1, \ldots, k$ versus all future periods. The intertemporal substitution effects generated by the consumption taxes thus work to improve the trade balance in periods $t = 1, \ldots, k$. On the other hand, the international reserve target calls for subsidies to international borrowing in periods $t = 1, \ldots, k$, and the attendant intertemporal substitution effects should serve to worsen the trade balance in periods $t = 1, \ldots, k$. However, since the subsidies to international borrowing are designed to mitigate the distortions introduced by the consumption taxes, there is some presumption that the latter will dominate so that intertemporal substitution effects will act to improve the trade balance. However, if the wealth effects dominate these substitution effects, the trade balance will, on average, deteriorate in periods $t = 1, \ldots, k$, and the country's external wealth, b^k, will fall even though international reserves increase to the target level $\tilde{b}_R$.

11. Remarks similar to those in footnote 8 apply here also.

12. For the results that follow, the weaker condition that $\bar{b}p^t + \mu^t$ *be constant for* $t = 1, \ldots, k$ is actually all that is required.

13. Again, following the suggestion made in footnote 6, it can be shown that the optimum subsidy to international borrowing is $\delta^t[\alpha^t - \alpha^{t-1}/(1 + i)]s_Z^t$, where $\alpha^t \equiv 0$ for $t = k + 1, \ldots$.

14. If the monetary mechanism of exchange dictates that transactions be carried out in the buyer's currency rather than in the seller's currency as is assumed here, the money market equilibrium condition (10) would be replaced by

$$m_s^t = X^t + p^t Z^t, \; t = 1, 2, \ldots.$$

As discussed by Helpman and Razin (1984), when the buyer's currency is used for transactions purposes the constraint (11) remains intact so long as foreign nominal interest rates and the rate of depreciation of the home currency, ϵ^t, are constant. In this case it is easy to show that the results for a trade balance target are unaffected while the results for a reserve target and a balance of payments target are modified somewhat. In both instances the qualitative pattern for consumption taxes and taxes on international borrowing is the same as in the body of the paper, but the optimal policy no longer calls for subsidizing domestic production. That is, when the buyer's currency is used for transactions purposes, optimal policies for balance of payments objectives do not involve distorting production decisions. An important corollary of this, of course, is that when the buyer's currency is used for transactions purposes, tariffs, export subsidies, and the like are not a part of the optimal tax policy for balance of payments objectives. The rationale for these results is that when the buyer's currency is used to finance transactions, production distortions do not help to improve the balance of payments. It is, therefore, optimal to leave production decisions undistorted. However, even when the buyer's currency is used to finance transactions it is still true that, unlike a trade balance target, reserve targets and balance of payments targets call for within-period distortions to be introduced.

15. See Kimbrough (1986b, 1986c) for a closed-economy version of the framework that is being suggested here.

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Comment Joshua Aizenman

Introduction

Kimbrough articulates a very useful intertemporal framework for studying optimal policies in an open economy. These policies are applied to achieve exogenous balance of trade and international reserves targets, and they are derived in a welfare framework that recognizes the role of intertemporal budget constraints. The author should be praised for a clear exposition. Kent's methodology is rich. It is, however, applied only to a rather simple economy that includes enough Ricardian features to nullify the role of optimal policies. If we allow for departures from Ricardian assumptions, a richer interpretation of the policies studied in this paper is possible. I will describe such extensions and suggest applications of the methodology for economies in which optimal policies matter, and for which the policy targets can be derived endogenously, rather than postulated exogeneously as in Kimbrough's paper. My comments include three parts. I will start with a brief review of Kimbrough's methodology. Next, I will discuss the monetary framework. Finally, I will suggest possible extensions of the methodology to a non-Ricardian world.

The Methodology

Kimbrough assumes an economy composed of consumers having an infinite horizon, with access to financial markets, and the authorities. Consumer income is generated by producing two goods, transfer payments, and income accruing to the financial portfolio. Money is introduced in a Clower fashion, where domestic money buys domestic goods, and foreign money buys foreign goods. The authorities are composed of two consolidated branches: the fiscal branch, responsible for imposing and collecting the various taxes, and the monetary branch, which manages the exchange rate and the credit policy. The economy is small, and the authorities have the capacity to impose all policies needed to achieve appropriate marginal conditions.

The authorities solve the optimizing problem in two stages. First, the policymaker maximizes an expression of the type

$$\text{(1)} \qquad U + \lambda[NPV^*] + \sum_{i=1}^{k} \theta_i H_i \, ,$$

where U is the utility of a representative consumer: NPV* is the intertemporal budget constraint, equalizing the net present value of consumption and production evaluated at the *world* prices and interest

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rates. H_i is the constraint imposed by the policy target i. In optimizing equation (1) the policymaker chooses the optimal path of consumption and production. Armed with the resultant optimal path, the policymaker then moves to the second stage—a design of a menu of taxes to motivate consumers and producers to follow the optimal consumption and production plans. The two-stage methodology simplifies the calculations in such a way that we use the world undistorted prices in stage 1, and we solve for the implied set of taxes only in stage 2.

Kimbrough's article analyzes two distinct sets of issues. First, he examines the design of policies aimed at a balance of trade targets (sections 9.4–9.5). Second, he studies policies aimed at international reserves targets. (sections 9.6–9.7). Trade balance targets are shown to be equivalent to intertemporal consumption targets. To invoke taxes on intertemporal borrowing is thus shown to be optimal. This policy changes the intertemporal prices so that we obtain the desired path of consumption. Optimal policies do not, however, include changes in the within-period relative prices. The second set of targets, related to international reserves, is achieved by using all policy instruments, changing both the within-period and the intertemporal prices.

The Monetary Framework

In developing the monetary sector Kimbrough adopts the cash-in-advance formulation. Accordingly, agents are required to purchase the goods of a country with the money of that country. In this formulation the demand for money does not depend on the interest rate. It is useful to assess the role of the monetary framework in policy-instruments determination. The two sets of issues analyzed by Kimbrough differ sharply from each other in terms of the robustness of the results with respect to changes in the monetary framework. The policy prescriptions relevant for the attainment of the second set of targets (related to reserves and balance of payments objectives) are not robust. Sensible changes in the monetary framework alter the results. As is reported by the author in footnote 14, if the domestic currency is used to finance domestic consumption of both goods, optimal policies aimed at achieving the second set of targets are altered significantly. Furthermore, if one abolishes the Clower constraint in favor of a flexible velocity technology of exchange, the results are affected considerably. Crude empiricism suggests that in most cases the monetary mechanism is indeed of the flexible velocity type, where only domestic money is used in financing consumption of both types of goods.[1] There is, however,

1. Another bothersome feature of the monetary framework applied in the paper is the absence of real balance effects. As is shown by Feenstra (1985), this reflects the specific assumptions regarding the sequence of exchange of goods and money. Note also that a Clower constraint of the type applied in the article implies that inflation tax can be applied to achieve costlessly any revenue target (up to almost all the G.N.P.). These

another difficulty with the proposed policies. As the author rightly points out, the same reserves and balance of payments targets can be achieved at a lowest cost by the appropriate monetary policy, reflecting the comparative advantage of the monetary policy in reaching reserves objectives. Kimbrough offers no economic reason for studying reserves targets in terms of an inferior framework, where only taxes (and subsidies) are instrumental in achieving balance of payments objectives.

Unlike the balance of payments targets, the first set of targets (related to balance of trade objectives) is achieved using policies that are robust with respect to changes in the monetary framework. Kimbrough's analysis of the balance of trade objective provides important insight into this issue.

Extensions and Qualifications

In Kimbrough's analysis, the attainment of all targets reduces welfare, and no clear economic interpretation is provided for the existence of welfare-reducing targets. This is a necessary feature of the Ricardian framework invoked in the paper; in such a framework, any policy is welfare-reducing. Relaxation of the assumptions underlying the Ricardian framework may not be simple but, at the same time, is highly desirable. Specifically, in a non-Ricardian framework the policy targets can be derived endogenously, and the policy instruments have a richer interpretation. In the following comments I would like to propose an alternative interpretation of the results regarding the balance of trade targets and describe non-Ricardian justification for various policies.

An Alternative Ricardian Interpretation of Policies Aimed at Balance of Trade Targets

Kimbrough's results regarding a balance of trade targets have an alternative interpretation, in terms of traditional commercial policies. Equation (13) in the paper can be used to demonstrate that an import level target at time t (IM_t) calls for import tax at time t ($I.T._t$) . We can summarize this result by

$$IM_t \Rightarrow I.T._t \tag{2a}$$

Similarly, an export target at time t (EX_t) calls for an export subsidy at time t ($E.S._t$) :

$$EX_t \Rightarrow E.S._t \tag{2b}$$

As a result, a balance of trade target at time t ($B.O.T._t$) calls for the simultaneous use of both a tariff and an export subsidy at time t, and optimally calls for equal rates:

considerations suggest that the applicability of a rigid Clower constraint in a public finance context is questionable.

(3) $$\text{B.O.T.}_{,t} \Rightarrow (\text{E.S.}_{,t} \; \& \; \text{I.T.}_{,t})\Big|_{\substack{\text{equal}\\\text{rates}}}$$

In general, these two policies are equivalent to a uniform consumption tax at time t (C.T.$_{,t}$) *and* a uniform equal production subsidy at time t (P.S.$_{,t}$) . Subject to Ricardian equivalency (R.E.), these policies are equivalent also to a tax on intertemporal borrowing applied at time t (T.B.$_{,t}$) :

(4) $$[(\text{E.S.}_{,t} \; \& \; \text{I.T.}_{,t})\Big|_{\substack{\text{equal}\\\text{rates}}} \approx (\text{C.T.}_{,t} \; \& \; \text{P.S.}_{,t})\Big|_{\substack{\text{equal}\\\text{rates}}} \;] \overset{\substack{\text{R.E.}\\\downarrow}}{\approx} \text{T.B.}_{,t}$$

In general, however, a segmented capital market will require the simultaneous use of *both* borrowing and consumption/production taxes and subsidies. We turn now to a brief examination of this possibility.

Limited Access to Capital Markets

Suppose that a typical less-developed country faces a balance of trade target. Would intertemporal taxes on borrowing be the optimal policy instrument, as suggested in Kimbrough's article? This seems unlikely, but the methodology applied in the paper is useful in assessing the problem, nevertheless. To take an extreme case, suppose that consumers, in contrast with government, do not have free access to capital markets. The planner problem can still be specified in terms of equation (1). The first-order conditions (equations 14 a–c in the text) are still relevant. The implied policies, however, differ sharply. Notice that the first-order conditions for a balance of trade target (equations 14 a–c) can be written as

(5) $$\frac{MU_x^t}{MU_x^{t-1}} = k_t\left(\frac{1}{1 + r_{t-1}^*}\right)$$

where MU_x^t is the marginal utility of x at time t, r_{t-1}^* is the world interest rate, and k_t depends on the tightness of the balance of trade target.[2] In the paper, equation (5) has the interpretation that a balance of trade calls for taxes on international borrowing such that the domestic interest rate (r_{t-1}) satisfies

2. Equation (2) assumes that the foreign price of X is normalized to 1. Similar equation applies for Y, where P_t^* stands for the external relative prices at $t(P_t^* = P_{y,t}^*/P_{x,t}^*)$:

$$\frac{MU_y^t}{MU_y^{t-1}} = k_t\frac{P_t^*}{P_{t-1}^*}\frac{1}{1 + r_{t-1}^*}.$$

$$k_t\left(\frac{1}{1 + r^*_{t-1}}\right) = \frac{1}{1 + r_{t-1}} \tag{6}$$

It is noteworthy that there is a broader interpretation of equation (5). In general, a desired change in international prices can also be achieved by a set of time varying uniform consumption taxes, such that:

$$k_t\left(\frac{1}{1 + r^*_{t-1}}\right) = \frac{1 + \epsilon_t}{(1 + \epsilon_{t-1})(1 + r_{t-1})} \tag{6'}$$

where ϵ_t stands for the consumption tax at time t. In a Ricardian economy the two policies (i.e., a borrowing tax and an intertemporal uniform consumption, and production taxes and subsidies) are equivalent. Notice, however, that once consumers lack access to capital markets, taxes on international borrowing are not an efficient means of reaching the desired intertemporal shadow prices. Equation (5) is still valid. But the appropriate policy will involve imposition of uniform (time varying) consumption and production taxes rather than taxes on borrowing. In the general case, with limited participation of some agents in the financial market, a balance of trade target will require the simultaneous use of both borrowing and uniform (time varying) consumption taxes. Even in this non-Ricardian economy, a major conclusion of Kimbrough's analysis is relevant: balance of trade targets are achieved optimally by leaving within the period relative prices intact.

Costs of Tax Collection and Revenue Targets

Most countries, especially L.D.C.s, are confronted with a tax system in which there are direct collection and enforcement costs associated with various taxes. The presence of collection costs can explain the economics of various distorting policies that lack the appropriate economic justification in a Ricardian world. The problem of the authorities, for example, can be cast in terms of the maximization of a modified version of equation (1), optimizing consumers' welfare subject to a net revenue target:

$$\begin{aligned} &U + \lambda\,[\mathrm{NPV}^*(C + G + C.C. - G.N.P.)] \\ &\quad + \theta[\mathrm{NPV}^*(G - (T - C.C.))], \end{aligned} \tag{1'}$$

where C is private consumption, G is public sector consumption, C.C. is the direct cost of collecting and enforcing taxes, G.N.P. stands for output, G is government consumption, T is the gross tax revenue (including the collection costs C.C.), and NPV* is the net present value obtained using *world* prices.[3] Such a framework can be applied to

3. Thus, C + G + C.C. − G.N.P. = 0 is the economy-wide budget constraint, and G − (T − C.C.) = 0 is the public sector budget constraint.

demonstrate that a weak fiscal system will tend to use both inflation tax and tariffs because both have low collection costs.[4] Furthermore, it can be shown that if the policy target is allocative, we tend to use only one instrument. If the target is the level of imports, only a tariff should be used. If the target is an intertemporal consumption path, only taxes on borrowing should be used. If the target is to raise revenue, then under restrictive conditions on the feasible set of taxes, both tariffs and borrowing taxes will be used.[5] In general, costs of tax collection suffice to explain the application of various policies that otherwise lack an economic justification.

Country Risk

Reserves targets are discussed in sections 9.6–9.7. These targets are welfare reducing in the context of Kimbrough's framework. They can be rationalized for a country facing an upward sloping supply of credit due to country-risk considerations. Such a country will benefit from appropriate build-up of international reserves by the authorities. The authorities will rely on reserves in servicing the debt during a recession where the feasible tax base is small, and will replenish reserves during expansion. Naturally, in a Ricardian world such a task is redundant (or even welfare reducing). In a more realistic world, citizens of a country whose authorities have limited taxing capacity tend to be barred from the international credit market, leaving an important consumption smoothing role for the authorities.[6]

Concluding Remarks

This article presents a very useful methodology for designing optimal policies to achieve exogenous targets. The methodology is even more useful when applied in a non-Ricardian framework. Such an application should modify the analysis in (at least) two ways. First, in a non-Ricardian framework the various policy targets can be derived endogenously. Second, non-Ricardian considerations will affect the optimal policy instruments. For example, in a Ricardian system traditional policies aimed at a balance of trade targets (like a time varying uniform tariffs and uniform equal export subsidies) are equivalent to a tax on intertemporal borrowing. Segmented capital markets break this equivalency, necessitating the use of *both* traditional policies and taxes on intertemporal borrowing. In general, greater segmentation of capital

4. See Aizenman (1985b).
5. See Aizenman (1986).
6. Implications of limited taxing capacity on international borrowing are analyzed by Sachs (1984). On the use of international reserves, see Frenkel and Aizenman (1982). For an analysis of the role of country risk, see Edwards (1985) and Harberger (1976).

markets tend to put a greater weight on tarrifs and export promotions as the efficient means of reaching balance of trade targets. It is noteworthy that even in this non-Ricardian economy, an important insight of Kimbrough's analysis is relevant: balance of trade targets are achieved optimally by leaving within the period relative prices intact.

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Comment Robert G. Murphy

Introduction

The article by Kent Kimbrough presents a neatly worked-out solution for the structure of optimal distortionary taxes in an economy facing certain noneconomic constraints on either its trade account or its balance of payments. In particular, for the cases involving balance of payments constraints the author provides very clearly the economic intuition behind what turn out to be rather complicated sets of optimal taxes and subsidies on consumption, production, and borrowing.

The analysis is carried out using a cash-in-advance technology of monetary exchange that implies a unitary velocity of money. In my comments I will consider the extent to which this mechanism of monetary exchange is critical for some of the policy prescriptions presented by Kimbrough, but relatively unimportant for others. In addition, I will raise a few concerns of mainly an expositional nature.

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Monetary Mechanisms and Optimal Taxes

In Kimbrough's article, the particular timing of transactions assumed for the economy along with the cash-in-advance constraint imply a unitary velocity of money. This constant velocity of money assumption links the demand for money directly to the value of domestic production in a rigid fashion. It is this link between domestic production and money demand that determines in part the nature of the policy prescriptions obtained in the paper.

There are two types of noneconomic objectives considered in the paper. One type involves either a cumulative trade balance (wealth) target over a given time interval or a separate trade balance target for each period during a given time interval. The other type involves either a cumulative balance of payments (reserve) target over a given time interval or separate balance of payments targets during a given time interval. The article finds that for objectives related to the trade balance, optimal policy involves only taxes on borrowing during periods when the constraint binds. No within-period distortions on consumption or production are prescribed. It appears that this is a rather general result, one that is *not* dependent on the manner in which money is modeled (although dependent on utility being separable across periods and agents having infinite horizons). The reason the monetary mechanism does not matter here is that trade balance targets to not require any change in the intertemporal pattern of the excess flow demand for money. All that is needed is to alter the intertemporal pattern of consumption.

For objectives relating to the balance of payments, the article shows that optimal policy involves, in general, taxes or subsidies on production, consumption, and borrowing during the periods when the constraint binds. Production and consumption choices are distorted through taxes and subsidies so as to increase the excess flow demand for money and, hence, meet the balance of payments target. Borrowing is subsidized so as to alleviate the welfare loss arising from distortion of within period choices. These results appear to be critically dependent on the manner in which money is modeled. The reason for this is that in order to meet a balance of payments constraint, the government must alter the intertemporal pattern of the excess flow demand for money. The policies that are necessary to achieve these objectives are therefore strongly influenced by the nature of the monetary mechanism.

To illustrate these points, consider an alternative method of modeling money where consumers hold domestic money to reduce the time spent transacting. Furthermore, assume that utility is a function of leisure as well as goods. If labor supply is assumed to be inelastic, as in Kimbrough's paper, then the level of real money balances will directly affect the level of utility but will have *no* direct effect on production. In this framework where the velocity of money is permitted to vary, the government seeks to maximize (notation follows Kimbrough)

$$(1) \qquad \sum_{t=1}^{\infty} \rho^{t-1} u(X^t, Z^t, m^t)$$

subject to the constraint that the present value of consumption equal the present value of production and the particular constraint associated with possible noneconomic objectives. For the case of a k-period cumulative trade balance (wealth) target of $\bar{b}$, the LaGrangian expression is

$$(2) \qquad \operatorname*{Max}_{\{X^t, Z^t, m^t, p_s^t\}} \sum_{t=1}^{\infty} \rho^{t-1} u(X^t, Z^t, m^t) + \lambda \Sigma d^{*t}\{X_s^t(p_s^t) - X^t + p^{*t}[Z_s^t(p_s^t) - Z^t]\} + \theta\{\sum_{t=1}^{k} d^{*t}[X_s^t(p_s^t) - X^t + p^{*t}[Z_s^t(p_s^t) - Z^t]] - d^{*k}\bar{b}\}$$

First-order conditions for this problem are identical to those obtained in Kimbrough's approach except for the additional condition that nominal interest rates be set equal to zero via the optimal rate of inflation. Likewise, results for the case of separate trade balance targets in each period during a given time interval are equivalent for both the money-in-the-utility function approach and Kimbrough's approach.

For the case of a k-period cumulative balance of payments (reserves) target of $\bar{b}_R$, the LaGrangian expression for a money-in-utility function approach is:

$$(3) \qquad \operatorname*{Max}_{\{X^t, Z^t, m^t, p_s^t\}} \sum_{t=1}^{\infty} \rho^{t-1} u(X^t, Z^t, m^t) + \lambda \Sigma d^{*t}\{X_s^t(p_s^t) - X^t + p^{*t}[Z_s^t(p_s^t) - Z^t]\} + \alpha\{\sum_{t=1}^{k-1} d^{*t}\left[\frac{u_m^t}{u_X^t} m^t - \mu^t\right] + d^{*k}[m^k - \mu^k - \bar{b}_R]\}$$

where the consumer's first-order condition for holdings of real balances, $u_m^t/u_X^t = i^t/(1 + i^t)$ is accounted for in the goverment's optimization problem. The first-order conditions for the government's policy involve conditions for consumption, production, and borrowing, as well as for real money balances. The first-order conditions for consumption and production are

$$(4a) \qquad u_Z^t/u_X^t = \begin{cases} \dfrac{p^{*t} - \dfrac{\alpha m^t}{u_X^t \lambda} \quad u_{mZ}^t - \dfrac{i^t}{1 + i^t} u_{XZ}^t}{1 - \dfrac{\alpha m^t}{u_X^t \lambda} \quad u_{mX}^t - \dfrac{i^t}{1 + i^t} u_{XX}^t}, & t = 1, \ldots, k-1, \\ u_Z^t/u_X^t = p^{*t}, & t = k, k+1, \ldots, . \end{cases}$$

$$\text{(4b)} \qquad \frac{-\partial X_s^t/\partial p_s^t}{\partial Z_s^t/\partial p_s^t} = p^{*t}, \qquad \text{for all } t.$$

The optimal policy here does not involve *any* production distortion and involves distorting consumption choices only in periods prior to period k. These results differ sharply from Kimbrough's where, production is subsidized in periods one through k and consumption is distorted most heavily during the last period of the constraint. Similar differences in results between the money-in-the-utility function approach and Kimbrough's approach arise for the case of a separate balance of payments target in each period. Thus, the results for optimal tax policy when facing balance of payments targets are extremely sensitive to the manner in which money is modeled.

Expositional Issues

The author does not discuss the production side of the economy in any detail. For instance, the issue of how transactions in factor markets occur is left to the imagination of the reader. In addition, the timing of transactions in goods markets seems somewhat confusing. An agent is described as receiving at the beginning of the period a payment for the goods he sold last period. However, the same agent is described as buying goods at the end of the period. Presumably another agent sells the goods and receives payment? Or is there a "firm" present that pays out "dividends" next period? Clarification of these timing issues would be helpful.

At various points in the article the author notes that the cash-in-advance constraints will be binding when nominal interest rates are positive. This is described as occurring when the nominal interest rate exceeds "the rate dictated by the optimum quantity of money rule." In the context of a model in which inflation has *no* effect on the velocity of money, however, it is not very informative to frame the discussion in terms of the optimal inflation tax.

Conclusion

To summarize briefly, I have strong reservations concerning the particular mechanism of monetary exchange employed by Kimbrough. The unitary velocity of money assumption implied by his monetary framework is of critical importance for the qualitative nature of policies seeking to attain targets related to the overall balance of payments. Future research should attempt to derive optimal policies for achieving balance of payments objectives in settings that permit more plausible mechanisms of monetary exchange. In particular, the role of inflation in distorting consumer behavior should be recognized.

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