

ANO 2004/18

Oslo  
December 29, 2004

# Working Paper

Research Department

Savers, Spenders and Fiscal Policy in a Small Open Economy

by

Egil Matsen, Tommy Sveen and Ragnar Torvik

Working papers fra Norges Bank kan bestilles over e-post:  
posten@norges-bank.no  
eller ved henvendelse til:  
Norges Bank, Abonnementsservice  
Postboks 1179 Sentrum  
0107 Oslo  
Telefon 22 31 63 83, Telefaks 22 41 31 05

Fra 1999 og senere er publikasjonene tilgjengelige som pdf-filer  
på [www.norges-bank.no](http://www.norges-bank.no), under "Publikasjoner".

Working papers inneholder forskningsarbeider  
og utredninger som vanligvis  
ikke har fått sin endelige form.  
Hensikten er blant annet at forfatteren  
kan motta kommentarer fra kolleger  
og andre interesserte.

Synspunkter og konklusjoner i arbeidene  
står for forfatterens regning.

*Working papers from Norges Bank can be ordered by e-mail:  
posten@norges-bank.no  
or from Norges Bank, Subscription service,  
P.O.Box. 1179 Sentrum  
N-0107Oslo, Norway.  
Tel. +47 22 31 63 83, Fax. +47 22 41 31 05*

*Working papers from 1999 onwards are available as pdf-files on the bank's  
web site: [www.norges-bank.no](http://www.norges-bank.no), under "Publications".*

*Norges Bank's working papers present  
research projects and reports  
(not usually in their final form)  
and are intended inter alia to enable  
the author to benefit from the comments  
of colleagues and other interested parties.*

*Views and conclusions expressed in working papers are  
the responsibility of the authors alone.*

ISSN 0801-2504 (printed) 1502-8143 (online)

ISBN 82-7553-274-4 (printed), 82-7553-275-2 (online)

# Savers, Spenders and Fiscal Policy in a Small Open Economy\*

Egil Matsen<sup>†</sup>

Tommy Sveen<sup>‡</sup>

Ragnar Torvik<sup>§</sup>

December 29, 2004

## Abstract

This paper analyzes the effects of fiscal policy in an open economy. We extend the savers-spenders theory of Mankiw (2000) to a small open economy with endogenous labor supply. We first show how the Dornbusch (1983) consumption-based real interest rate for open economies is modified when labor supply is endogenous. We then turn to the effects of fiscal policy when there are both savers and spenders. With this heterogeneity taken into account, tax cuts have a short-run contractionary effect on domestic production, and increased public spending has a short-run expansionary effect. Although consistent with recent empirical work, this result contrasts with those of most other theoretical models. Transitory changes in demand have permanent real effects in our model, and we discuss the implications for real exchange-rate dynamics. We also show how “rational” savers may magnify or dampen the responses of “irrational” spenders, and show how this is related to features of the utility functions.

**Keywords:** rule-of-thumb consumers, fiscal policy, open economy.

**JEL Classification:** E21, E62, F41.

---

\*We thank Kimberley Jordan, Assar Lindbeck, Dirk Niepelt, Øistein Røisland, Fabrizio Zilibotti, and participants in seminars at IIES (Stockholm), NHH (Bergen), and our affiliated institutions for their helpful comments. Matsen acknowledges financial support from the Research Council of Norway. The views expressed are those of the authors, and not necessarily those of Norges Bank.

<sup>†</sup>Norwegian University of Science and Technology and Norges Bank (The Central Bank of Norway). Corresponding author. Address: NTNU, Department of Economics, Dragvoll, NO-7491 Trondheim, Norway. Email: egilm@svt.ntnu.no

<sup>‡</sup>Norges Bank. Email: tommy.sveen@norges-bank.no

<sup>§</sup>Norwegian University of Science and Technology and Norges Bank. Email: ragnarto@svt.ntnu.no

# 1 Introduction

Economists typically base their analyses of fiscal policy on forward-looking theories of consumer behavior; namely, the representative-agent permanent-income model or the life-cycle overlapping generations (OLG) model. However, empirical studies of fiscal policy effects do not support these models. In particular, the link between fiscal policy and private consumption seems to contradict the empirical predictions. Boskin (1988) and Poterba (1988), for instance, conclude that the impact of tax cuts on consumption is much larger than the neutral (or the very small) effect predicted by a life-cycle or permanent-income model. Similarly, Blanchard and Perotti (2002), Perotti (2002) and Galí *et al.* (2003) estimate a significant positive relationship between government spending and private consumption.<sup>1</sup> This is also difficult to reconcile with standard forward-looking models.

Boskin, Galí *et al.* and Poterba suggest that myopic “rule-of-thumb” behavior by households is a likely explanation of their empirical results.<sup>2</sup> The traditional Keynesian IS-LM-type model incorporates myopia because consumers only care about current income when making consumption decisions. However, the empirical studies referred to give little support to this model. The response of private consumption to tax cuts is substantially lower than that predicted by a standard Keynesian model. The estimates in Boskin (1988) suggest that the effects of tax cuts on consumption are “only one-third as large as the typical Keynesian estimate ...” (p. 401). Moreover, Perotti (2002) finds small effects of fiscal policy on GDP in five OECD countries. He finds a positive link between government spending and output, but the multipliers are generally less than unity. Perotti finds even smaller effects of tax cuts on GDP; his benchmark results indicate *negative* effects of tax cuts on GDP in Australia, Germany and the UK.<sup>3</sup>

In this paper, we present a model of a small open economy that can account for these stylized empirical observations. Our framework is based on Mankiw’s (2000) proposition that fiscal policy should be analyzed in the context of simple microeconomic heterogeneity in the form of *savers* and *spenders*.<sup>4</sup> Savers have long time horizons and smooth consumption from year-to-year and generation-to-generation, whereas spenders adopt the rule-of-thumb of consuming their disposable income in every period.<sup>5</sup> Several

---

<sup>1</sup>The studies referred to are based on US data, except that of Perotti (2002). Perotti analyzes data from Australia, Canada, Germany and the UK, in addition to the US.

<sup>2</sup>One can interpret rule-of-thumb behavior as a result of either credit-market imperfections in the form of borrowing constraints, or as a deviation from full rationality. Thaler (1992, p. 120) refers to “... two important sources of liquidity constraints: those imposed by capital markets, and those imposed by individuals on themselves.”

<sup>3</sup>Note however that Perotti finds the latter results “suspicious” (p. 24). He nevertheless concludes that the positive effects of tax cuts on GDP obtained by Blanchard and Perotti (2002) for the US are at “the high end of the spectrum” (p. 25) among OECD countries.

<sup>4</sup>Poterba (1988) also implicitly suggests that a framework with myopic and forward-looking agents could explain the empirical link between tax changes and consumption: “Myopia, if part of the explanation, is clearly not universal. There are obvious cases ... that suggest a substantial number of tax payers are responsive to preannounced changes in policy. The existence of such taxpayers, however, does not disprove of others who fail to look ahead.” (p. 417).

<sup>5</sup>Mankiw’s argument for this heterogeneity is based on facts about consumption behavior. On the

recent papers demonstrate that the inclusion of this simple heterogeneity in macroeconomic models provides important insights into the effects of macro-policies. Amato and Laubach (2003) and Galí *et al.* (2004) analyze monetary policy with rule-of-thumb behavior, and Mankiw (2000) and Galí *et al.* (2003) explore the implications of fiscal policy in *closed* economies.<sup>6</sup>

The introduction of openness into a spenders-savers framework provides new channels for fiscal policy that operate through real exchange rates and current account dynamics. We show that this challenges some closed-economy results, and importantly, that our results are consistent with the stylized facts of fiscal policy discussed above. First, in an open economy, tax cuts stimulate private consumption, but—in line with Perotti’s (2002) findings—have a negative effect on output. Thus, unlike in the closed-economy model of Mankiw (2000), tax cuts are not necessarily expansionary when some consumers behave in a “Keynesian” fashion (by consuming labor income).

Second, like Galí *et al.* (2003), we find that increased government spending can increase private consumption. However, Galí *et al.* (2003, p. 3) argue that “... the coexistence of sticky prices and rule-of-thumb consumers is a necessary condition for an increase in government spending to raise aggregate consumption.” While this may be the case in a closed economy, we show that imposing sticky prices is not necessary for increased public spending to increase consumption in an open economy. The reason is that spenders affect the path for the real exchange rate, and rational forward-looking savers take this into account. In closed-economy models, such effects are assumed away. We discuss the circumstances under which the response from savers either magnifies or dampens the response of spenders.

Our framework is most closely related to the early closed-economy models with spenders and savers, but is also related to other open-economy models. In particular, our analysis is closely related to the Dornbusch (1983) model of the equilibrium real interest rate in a small open economy. Assuming exogenous production, Dornbusch showed that the relevant interest rate facing domestic agents in such an economy is the world interest rate adjusted for intertemporal changes in the relative price of home goods. Our model allows for non-separable utility in consumption and leisure combined with endogenous production. In this case, we show that the relevant interest rate facing domestic savers is Dornbusch’s interest rate adjusted for intertemporal changes in the wage rate. The Dornbusch interest rate is a special case in our model.

Another closely related paper is Persson’s (1985) analysis of budget deficits and

---

one hand, aggregate consumer spending follows current aggregate income far more closely than is suggested by forward-looking theories (see, e.g., Campbell and Mankiw, 1991), and micro-data reveals that many households hardly save at all (see, e.g., Wolff, 1998), which suggests that they cannot smooth consumption over time.

On the other hand, some consumers seem to have long time horizons. Mankiw reports, for instance, that while the top five percent of people in the US income distribution earn 15-20 percent of total income, they hold 72 percent of the economy’s financial wealth. Such wealth accumulation suggests that motives such as bequests may be important, which implies that some households have long time horizons.

<sup>6</sup>The empirical importance of spenders is documented in a series of papers by Campbell and Mankiw (1989, 1990, 1991). They estimate that about half of US income is earned by rule-of-thumb consumers. Similar results have been obtained for other countries by other researchers.

public debt in open OLG models. He focuses on intergenerational welfare distributions of public debt, whereas we concentrate on short-run effects on relative prices and economic activity. Moreover, labor supply responses play an important role in our model, while labor supply is exogenous in Persson's paper.

We show how the interaction between heterogeneity, openness and labor supply determines real exchange-rate dynamics. Although our model incorporates constant returns to scale in production, taxes and public spending affect both short- and long-run real exchange rates. Due to the role of spenders, higher current transfers, for instance, raise labor demand and lower labor supply. Therefore, the short-run real exchange rate appreciates. However, in the long run, the real exchange rate must depreciate to below its initial level. This is because current higher transfers and demand must be met by lower future transfers and demand (unless savers completely counteract them, which does not occur in our model) and higher future labor supply. Thus, not only does the short-run real exchange rate overshoot its long-run value, it also moves in the opposite direction.

The paper is organized as follows. In section 2, we develop a small open-economy model with savers and spenders. In section 3, we briefly describe the market for domestically produced goods. In section 4, we describe the stationary equilibrium of the model. In section 5, which is the main section of the paper, we analyze the effect of different fiscal policies. Section 6 concludes the paper. Some derivations and a proof are relegated to the Appendix.

## 2 A small open economy with savers and spenders

We consider a small open economy that is inhabited by two types of household. In the spirit of Mankiw (2000), we denote them as *savers* and *spenders*, respectively. Savers are fully rational intertemporal maximizers, whereas spenders consume their entire after-tax labor income in every period. In addition, we follow Galí and Monacelli (2004) and model a continuum of small open economies indexed on the unit interval. Hence, each country is sufficiently small to have negligible effects on output, prices and the interest rate in other economies within the world economy. This enables us to treat all foreign variables as exogenous. Each economy comprises households, perfectly competitive firms and a fiscal authority. Different countries share the same technology, preferences and market structures, but are subject to idiosyncratic changes in fiscal policy. We next describe a typical small open economy, the home country, in detail.

### 2.1 Households

#### 2.1.1 Savers

A fraction  $1 - \lambda$  of households has access to an international financial market where they can save and borrow at the constant exogenous interest rate  $r$ . These households

maximize discounted utility:

$$U_t = \sum_{s=t}^{\infty} \beta^{s-t} u(c_s, l_s), \quad (1)$$

where the parameter  $\beta$  is the time discount factor and  $u(c_s, l_s)$  is period  $s$  utility, which depends on the amount of leisure,  $l$ , and consumption  $c$ . In what follows, we apply the following period utility function:

$$u(c_s, l_s) = \frac{[c_s^\gamma l_s^{1-\gamma}]^{1-\frac{1}{\sigma}}}{1 - \frac{1}{\sigma}}. \quad (2)$$

The parameter  $\sigma > 0$  denotes the elasticity of intertemporal substitution of utility and  $\gamma \in (0, 1)$ . The elasticity of intertemporal substitution with respect to consumption is  $[1 - \gamma(1 - \frac{1}{\sigma})]^{-1}$ . This elasticity equals  $\sigma$  when  $\gamma = 1$  and is equal to unity when  $\sigma = 1$ . Consumption and leisure are substitutes in utility if  $\sigma < 1$  and are complements otherwise.

Consumption is defined as a Cobb–Douglas aggregate over domestic goods ( $c_H$ ) and an index of foreign goods ( $c_F$ ):

$$c_s \equiv K c_{H,s}^{1-\alpha} c_{F,s}^\alpha, \quad (3)$$

where  $\alpha \in (0, 1)$  and the constant  $K \equiv 1/\alpha^\alpha (1 - \alpha)^{1-\alpha}$  is included to simplify some of the expressions that follow. The basket of foreign goods is given by:

$$c_{F,s} \equiv \int_0^1 c_{i,s} di. \quad (4)$$

where  $c_{i,s}$  denotes the domestic consumption of goods produced in country  $i \in [0, 1]$  in period  $s$ . Hence, we assume a unit elasticity of substitution between different imported goods. We adopt the basket of foreign goods as the numeraire, and since all domestic agents take its price as given, we can normalize its price to unity.

Savers must obey a sequence of budget constraints given by:<sup>7</sup>

$$p_s c_{H,s} + \int_0^1 c_{i,s} p_{i,s} di + \tilde{Q}_{s+1} = (1 + r) \tilde{Q}_s + W_s n_s + T_s, \quad (5)$$

where  $p_s$  and  $p_{i,s}$ , respectively, are the relative prices of domestic goods and goods from country  $i$  in period  $s$ . Both are expressed in terms of the basket of foreign goods. Moreover,  $\tilde{Q}_t$  denotes the stock of foreign assets held by domestic savers at the beginning of period  $t$ , and  $n_s \equiv 1 - l_s$  is hours worked, while  $W_s$  and  $T_s$  are the wage rate and net lump-sum transfers, respectively, both of which are measured in terms of foreign goods. Since we use foreign goods as the numeraire, the interest rate in (5) can be interpreted as the own-interest rate on foreign goods. Foreign assets are therefore bonds that yield a return of  $r\tilde{Q}$  units of foreign goods per period.

<sup>7</sup>Savers are also subject to the “No-Ponzi game” transversality condition.

The optimal allocation of expenditures on different imported goods implies the following demand functions:

$$c_{i,s} = p_{i,s}^{-1} c_{F,s}, \quad (6)$$

for all  $i \in [0, 1]$ . Likewise, the optimal allocation between domestic and imported goods implies:

$$c_{H,s} = (1 - \alpha) p_s^{-\alpha} c_s, \quad c_{F,s} = \alpha p_s^{1-\alpha} c_s, \quad (7)$$

where the consumer price index is given by:<sup>8</sup>

$$P_s \equiv p_s^{1-\alpha}. \quad (8)$$

The first-order conditions in (7) imply that the demand for each good is proportional to real consumption, with proportionality factors given by the relative prices. Note that, as in Galí and Monacelli (2004), the parameter  $\alpha$  is a natural measure of openness because  $1 - \alpha$  measures the extent of home bias in consumption.

For future reference, note that the identity for financial asset accumulation by savers is:

$$\tilde{Q}_{s+1} - \tilde{Q}_s = r\tilde{Q}_s + W_s n_s + T_s - P_s c_s. \quad (9)$$

Note also that the intertemporal budget constraint can accordingly be written as:

$$\sum_{s=t}^{\infty} \left( \frac{1}{1+r} \right)^{s-t} (P_s c_s + W_s l_s) = (1+r) \tilde{Q}_t + \sum_{s=t}^{\infty} \left( \frac{1}{1+r} \right)^{s-t} (W_s + T_s), \quad (10)$$

for which we have used the “No-Ponzi-game” transversality condition. The optimal allocation between consumption and leisure is then given by:

$$l_s = \frac{1-\gamma}{\gamma} \left( \frac{W_s}{P_s} \right)^{-1} c_s. \quad (11)$$

Equation (11) indicates how, in every period  $s$ , leisure depends on the current *consumer* real wage ( $\frac{W_s}{P_s}$ ) (henceforth, the real wage) and consumption. Labor supply is increasing in the real wage and is decreasing in real consumption.

The final first-order condition for savers is the Euler equation for consumption:

$$c_{s+1} = (1+r)^\sigma \beta^\sigma \left( \frac{W_s/P_s}{W_{s+1}/P_{s+1}} \right)^{(1-\gamma)(\sigma-1)} \left( \frac{P_s}{P_{s+1}} \right)^\sigma c_s. \quad (12)$$

Besides the usual effects of the interest rate and discount rate, the consumption growth of savers depends on the rate of real wage growth (unless  $\sigma = 1$ ) and on the rate of change in the price level. For given real wage growth, an increase in the rate of CPI inflation ( $P_{s+1}/P_s$ ) lowers consumption growth; this represents the Dornbusch (1983) effect. The partial effect of a change in real wage growth is ambiguous because it depends on whether

---

<sup>8</sup>This equation applies because spenders make the same *intra*temporal allocations as do savers; see below.

$\sigma \leq 1$ . Consider an increase in the growth rate of real wages (due, for example, to higher anticipated future wages). This stimulates savers' consumption growth when  $\sigma < 1$ . This effect is due to one *intertemporal* response and one *intratemporal* response. Both responses are related to the induced increase in future labor supply that is due to the wage increase. The first arises because when  $\sigma < 1$ , savers are unwilling to substitute *utility* over time and they counteract the fall in utility that is due to higher future work hours by increasing future consumption. The second arises because  $c$  and  $l$  are substitutes when  $\sigma < 1$  [ $\frac{\partial^2 u}{\partial c \partial l} < 0$ ]. Hence, lower future leisure raises the marginal utility of future consumption and thereby contributes to higher future consumption (relative to current consumption). When  $\sigma > 1$ , the explanation is analogous. Savers would be willing to substitute utility over time, and  $c$  and  $l$  would be complements. Therefore, the consumption growth of savers would fall were the growth rate of real wages to increase. With log utility ( $\sigma = 1$ ), consumption and leisure enter utility separably and changes in real wage growth have no effect on savers' consumption growth.

### 2.1.2 Spenders

The remaining share,  $\lambda$ , of households does not save, but instead spends the disposable income in every period. Mankiw (2000) discusses the reasons for such rule-of-thumb behavior.

Spenders solve the static problem:

$$\max u(c'_t, l'_t),$$

subject to  $l'_t = 1 - n'_t$  and the constraint that all of their disposable income is consumed. Hence, we have:

$$P_t c'_t = W_t n'_t + T_t. \quad (13)$$

where the prime denotes the consumption and labor supply of spenders, as opposed to savers. We assume that spenders have a period utility function that is analogous to (2), a Cobb–Douglas aggregator for domestic and foreign consumption as in (3), and an aggregator of foreign goods, as in (4). It follows that spenders' static allocations between different imported goods and between domestic and foreign goods are described by a first-order condition that is analogous to (6) and (7), respectively. Likewise, the choice between leisure and consumption for these households is determined by a first-order condition that is analogous to (11). By combining this with (13), we can express spenders' labor supply as:

$$n'_t = \gamma - \frac{T_t}{W_t} (1 - \gamma). \quad (14)$$

In the absence of transfers, the proportion of their time that spenders allocate to the labor market equals the weight on consumption in the utility function. Positive transfers reduce their labor supply. By substituting the labor-supply equation into (13), we can show that spenders' consumption is proportional to their real disposable incomes:

$$c'_t = \gamma \left( \frac{W_t + T_t}{P_t} \right). \quad (15)$$

### 2.1.3 Aggregate consumption and labor supply

Total consumption demand and the supply of hours in the economy are weighted averages of these variables for the two household groups:

$$C_t \equiv (1 - \lambda) c_t + \lambda c'_t \quad (16)$$

$$N_t \equiv (1 - \lambda) n_t + \lambda n'_t. \quad (17)$$

The determination of these variables is explained in the equilibrium analysis below.

## 2.2 Firms

Firms operate under perfect competition and have access to linear technology represented by  $Y_t = N_t$ . Profit maximization implies:

$$p_s = W_s. \quad (18)$$

In every period, the price of the domestic good is equal to the wage rate, and both are measured in terms of the foreign good.

## 2.3 The government

The fiscal authority determines net transfers in every period, and thus transfers are exogenous in our model. For simplicity, we initially disregard government consumption. An analysis of government spending is provided in section 5.2 below. In the same way as private savers, the government can borrow and lend abroad at an exogenous interest rate. Without public expenditure, the government's asset-accumulation identity is:

$$Q_{s+1}^G - Q_s^G = rQ_s^G - T_s,$$

where  $Q_t^G$  denotes the government's net foreign assets at the beginning of period  $t$  in units of the composite foreign good. This leads to the government's intertemporal budget constraint, which is:

$$\sum_{s=t}^{\infty} \left( \frac{1}{1+r} \right)^{s-t} T_s = (1+r) Q_t^G. \quad (19)$$

The present discounted value of transfers must equal the government's net assets (including asset income).

Note that (19) can be incorporated into (10) to yield:

$$\sum_{s=t}^{\infty} \left( \frac{1}{1+r} \right)^{s-t} P_s c_s = (1+r) (\tilde{Q}_t + Q_t^G) + \sum_{s=t}^{\infty} \left( \frac{1}{1+r} \right)^{s-t} W_s n_s. \quad (20)$$

This constraint demonstrates that savers are Ricardian in the accepted sense: they fully internalize their share of government wealth into their asset holdings when making consumption decisions. Moreover, transfers do not enter their budget constraint, and

hence do not directly affect their consumption decisions. However, we show subsequently that the timing of transfers does affect relative prices, and therefore wages and the aggregate price level, which in turn affect savers' consumption. We should also note that the term  $\tilde{Q}_t + Q_t^G$  in (20) differs from that representing the whole economy's net foreign-asset position. Total foreign-asset holdings are given by:

$$Q_t \equiv (1 - \lambda) \tilde{Q}_t + Q_t^G. \quad (21)$$

## 2.4 The rest of the world

The world economy is made up of small open economies as explained above, and therefore, first-order conditions for savers and spenders analogous to those for the domestic economy apply to each country  $i$ . Moreover, we assume, without loss of generality, that net transfers in the rest of the world are zero in every period; that is,  $T_{i,s} = 0 \forall i, s$ . We also assume that the distribution of savers and spenders is the same in every country (except possibly the domestic economy), and that initial conditions (except in the domestic economy, which has a measure of zero in the world economy) are symmetric.

These assumptions imply that in the domestic economy, the prices of imported goods are independent of their country of origin, and hence, their relative prices are unity. Therefore,  $c_{i,s} = c_{F,s} \forall i$ . Note that the normalization of a unitary price of the basket of foreign goods implies that the common price of imports is unity. This implies that the CPI of all countries other than the home country has a constant value of unity.

Denoting world-economy variables using an asterisk, and integrating over all countries, indexed by  $i$ , we therefore have:

$$l_s^* = \frac{1 - \gamma}{\gamma} c_s^*, \quad (22)$$

$$c_{s+1}^* = (1 + r)^\sigma \beta^\sigma c_s^*. \quad (23)$$

$$n_s^{*'} = c_s^{*'} = \gamma. \quad (24)$$

In addition, due to symmetry and since the current account is the only means of saving in each country, the real interest rate must be such that savings are zero for every period. Hence, we have:

$$1 + r = \beta^{-1}. \quad (25)$$

Consumption and labor supply in the world economy are therefore:

$$N_s^* = C_s^* = \gamma. \quad (26)$$

## 2.5 The real exchange rate, the terms of trade and the real interest rate

Before analyzing the equilibrium and the effects of fiscal policy in this model, it is useful to explain how the relative price of domestic goods determines the real exchange rate, the terms of trade and the real interest rate. Given (8), the effective real exchange rate

is simply  $p_s^{\alpha-1}$  in period  $s$ , while the effective terms of trade (i.e., the price of exports in terms of imports) is  $p_s$ . An increase in the relative price leads to a real exchange rate appreciation and an improvement in the terms of trade.

To define the real interest rate in this economy, we note that (8) and (18) imply that the Euler equation (12) can be restated in terms of relative prices, as follows:

$$\left(\frac{c_s}{c_{s+1}}\right)^{-\frac{1}{\sigma}} = \left[(1+r)\beta\left(\frac{p_s}{p_{s+1}}\right)^{1-\alpha}\right] \left(\frac{p_s}{p_{s+1}}\right)^{\frac{\alpha(1-\gamma)(\sigma-1)}{\sigma}}. \quad (27)$$

Hence, the consumption-based real interest rate facing domestic savers,  $r_{s+1}^c$ , is given by:

$$1 + r_{s+1}^c \equiv \left[(1+r)\left(\frac{p_s}{p_{s+1}}\right)^{1-\alpha}\right] \left(\frac{p_s}{p_{s+1}}\right)^{\frac{\alpha(1-\gamma)(\sigma-1)}{\sigma}}.$$

The first term on the right-hand side is equal to the consumption-based interest rate in Dornbusch (1983). Whenever the relative price is expected to increase (decrease) over time, this term contributes to lower (raise) the effective real interest rate. However, in the present model, this effect is augmented by the effect represented by the final term in the latter expression. This term arises because of the endogenous labor supply in our model. (It can be written as  $(W_s/W_{s+1})^{\alpha(1-\gamma)(\sigma-1)/\sigma}$ .) When  $\sigma < 1$ , this term raises the real interest rate when wages are increasing, thereby counteracting the ‘‘Dornbusch effect’’ on the real interest rate. When  $\sigma > 1$ , the Dornbusch effect is reinforced. When  $\sigma = 1$ , the usual borderline case, in which labor supply decisions do not interact with the consumption-based real interest rate, arises. In this special case, the consumption-based interest rate is the same as that in Dornbusch (1983). Note also that if relative prices are constant, i.e., if  $p_{s+1} = p_s$ , the consumption-based interest rate is equal to the world interest rate  $r$ .

### 3 The market for the domestic good

#### 3.1 Demand and supply of the domestic good

The demand for the domestically produced good can be expressed in terms of its relative price and aggregate domestic consumption:

$$C_{H,s} + C_{H,s}^* = (1-\alpha)p_s^{-\alpha}C_s + \alpha p_s^{-1}\gamma. \quad (28)$$

This expression follows from (6), (7), the analogous foreign relationships, and (26). The first term on the right-hand side represents domestic demand for the home good, while the second term represents foreign demand (i.e., exports). Both are negatively related to the relative price of the domestic good.

The supply of the domestically produced good can be expressed as:

$$Y_s = N_s = 1 - \frac{1-\gamma}{\gamma}p_s^{-\alpha}C_s, \quad (29)$$

where the first equality is the production function and the second follows from equilibrium in the labor market and labor supply from equation (11) (and the corresponding first-order condition for spenders).

Market clearing in the market for the domestic good yields an implicit relationship between aggregate consumption and the relative price of the domestic good:

$$C_s = \frac{\gamma}{1 - \alpha\gamma} (p_s^\alpha - \alpha\gamma p_s^{\alpha-1}). \quad (30)$$

Differentiating yields:

$$\frac{dp_s}{dC_s} = \frac{1/\gamma - 1}{\alpha p_s^{\alpha-1} - (\alpha - 1)\alpha\gamma p_s^{\alpha-2}} > 0. \quad (31)$$

The relative price of the domestic good is increasing in aggregate domestic consumption.

### 3.2 The current account and net exports

The current account is the difference between total income and domestic consumption:

$$Q_{s+1} - Q_s \equiv CA_s = rQ_s + p_s Y_s - p_s C_{H,s} - C_{F,s} \equiv rQ_s + TB_s, \quad (32)$$

where  $TB_s$  is the trade balance in period  $s$ , measured in terms of foreign goods. We combine the demand functions in (7) with equation (29) to express the trade balance in period  $s$  as:

$$TB_s = p_s - \frac{1}{\gamma} p_s^{1-\alpha} C_s.$$

In addition, we use (30) to express the equilibrium trade balance as a function of only the relative price:

$$TB_s = \frac{\alpha\gamma}{1 - \alpha\gamma} (1 - p_s). \quad (33)$$

An increase in the relative price of the domestic good, and hence, a real appreciation of the exchange rate, leads to a deterioration in the trade balance.

## 4 The stationary equilibrium

To discuss fiscal policy, it is reasonable to begin with the stationary equilibrium. In a stationary equilibrium, the relative price and net transfers are anticipated to be constant over time. Suppose that the small economy is in a stationary equilibrium in period  $t$ , so that the relative price is anticipated to remain constant at  $p = p_t$  and transfers are expected to be at the constant level  $T = T_t$ .

In the appendix, we derive a general consumption function for domestic savers; see equation (A.1). With a constant relative price  $p$  in the stationary equilibrium, this consumption function reduces to:

$$c_s = c = \gamma \left( \frac{r(\tilde{Q}_t + Q_t^G) + W}{p^{1-\alpha}} \right), \quad \forall s. \quad (34)$$

Given (11), constant consumption implies constant labor supply, as follows:

$$n_s = n = \gamma - (1 - \gamma)r \left( \tilde{Q}_t + Q_t^G \right) / W, \quad \forall s.$$

Hence, savers' labor income in the stationary equilibrium is as follows:

$$\begin{aligned} Wn &= \gamma \left[ W + r \left( \tilde{Q}_t + Q_t^G \right) \right] - r \left( \tilde{Q}_t + Q_t^G \right) = p^{1-\alpha} c - r \left( \tilde{Q}_t + Q_t^G \right) \\ \Leftrightarrow c &= \frac{Wn + r \left( \tilde{Q}_t + Q_t^G \right)}{p^{1-\alpha}}. \end{aligned} \quad (35)$$

Savers' consumption in the stationary equilibrium is equal to the real value of their labor income plus the permanent income of their consolidated net foreign assets.

With regard to spenders' stationary consumption, first note that, from (19), constant transfers imply:

$$T_s = T = rQ_t^G, \quad \forall s.$$

By substituting this into (15), we find the stationary consumption of spenders:

$$c'_s = c' = \gamma \left( \frac{rQ_t^G + W}{p^{1-\alpha}} \right), \quad \forall s. \quad (36)$$

Only the government's asset position is relevant to spenders because spenders do not accumulate assets themselves. A high-wealth government permits high stationary transfers, and this increases spenders' consumption. Similarly, government assets influence spenders' labor supply negatively in the stationary equilibrium, as follows:

$$n'_s = n' = \gamma - (1 - \gamma)rQ_t^G / W, \quad \forall s.$$

Aggregate labor supply and output in the stationary equilibrium can now be written as:

$$\begin{aligned} Y &= N = \lambda \left[ \gamma - (1 - \gamma) \frac{rQ_t^G}{W} \right] + (1 - \lambda) \left[ \gamma - (1 - \gamma) \frac{r(\tilde{Q}_t + Q_t^G)}{W} \right] \\ &= \gamma - (1 - \gamma) \frac{rQ_t}{W}. \end{aligned} \quad (37)$$

The last equality makes use of the definition of total foreign assets (21). The higher is aggregate financial wealth and the more important is leisure in generating utility, the lower is aggregate labor supply and output in the stationary equilibrium. Note that aggregate labor income is:

$$WN = \gamma W - (1 - \gamma)rQ_t.$$

Aggregate consumption in the stationary equilibrium follows from (34) and (36):

$$C = \gamma \left( \frac{W + rQ_t}{p^{1-\alpha}} \right) = \frac{WN + rQ_t}{p^{1-\alpha}}. \quad (38)$$

The second equality follows from the expression for aggregate labor income above. In the stationary equilibrium, aggregate consumption is equal to real aggregate labor income plus real permanent income from total foreign assets. Note that the distribution of households between savers and spenders has no effect on consumption and output in the stationary equilibrium. Given the stationary transfer policy of the government, total consumption is equal to aggregate income (including asset income) for both savers and spenders.

Next, consider the relative price of domestic goods. We use (38) in (30) to express the relative price of the domestic good in the stationary equilibrium as follows:

$$p = 1 + \frac{1 - \alpha\gamma}{\alpha\gamma} rQ_t. \quad (39)$$

The stationary equilibrium price is higher the higher the country's net foreign-asset holdings (and hence the real exchange rate is "stronger" and the terms of trade are better). With zero net initial foreign-asset holdings, as for the other countries in the world economy, the relative price of domestic goods would be unity in the stationary equilibrium. For a given positive level of foreign assets in stationary equilibrium, the relative price is lower the more open is the economy, and the less important is leisure in generating utility (i.e., the higher is labor supply).

Finally in this section, we use (39) in (33) to demonstrate that  $TB = -rQ_t$  in the stationary equilibrium. The small economy runs a trade deficit (surplus) equal to its income from foreign assets (debt). Thus, the current account is zero in the stationary equilibrium.

## 5 Fiscal policy

In this section, we analyze fiscal policy in the presence of savers and spenders. Two types of fiscal experiments are considered. The first is a "Ricardian"-type experiment in which the government lowers taxes (increases transfers) in one period, and then increases taxes to a constant level in the following period. In the second experiment, we analyze the effects of a one-period increase in government spending.

To simplify notation, we assume that both savers and the government initially have no foreign assets ( $\tilde{Q}_t = Q_t^G = 0$ ). This implies that the *ex ante* stationary equilibrium price is  $p = 1$ .

### 5.1 A transitory tax cut

Suppose that instead of holding transfers fixed at  $T = rQ_t^G = 0$ , as in the *ex ante* stationary equilibrium, the government increases transfers (cuts taxes) to  $T_t = T^H > 0$  and then reduces transfers to a new permanent level  $T^L$  in period  $t+1$ , such that  $T_s = T^L \forall s > t$ . From (19), it follows that:

$$T^L = -rT^H < 0. \quad (40)$$

That is, the permanent level of taxes, from period  $t + 1$ , is equal to interest payments on the foreign borrowing necessary to finance the period  $t$  tax cut. Note that, under this policy, the level of public debt,  $Q_{t+1}^G = -T^H$ , is constant from  $t + 1$ .

From period  $t + 1$ , the economy is again in a stationary equilibrium, and has adjusted to the new lower level of permanent transfers. Hence, the results derived in section 4 apply. In particular, equation (39) implies:

$$p_s = p_{t+1} = 1 + \frac{1 - \alpha\gamma}{\alpha\gamma} r Q_{t+1}, \quad \forall s > t.$$

To show how the new stationary equilibrium price relates to the price in period  $t$ , we use the current account equation, (32), and the equilibrium trade balance, (33), to substitute for  $Q_{t+1}$ . This substitution yields:

$$p_{t+1} = (1 + r) \left[ 1 + \frac{1 - \alpha\gamma}{\alpha\gamma} r Q_t \right] - r p_t.$$

Given (39), the term in square brackets is the relative price that would have prevailed without the change in fiscal policy (i.e., the price in the *ex ante* stationary equilibrium). Thus, we have:

$$p_{t+1} = (1 + r) p - r p_t = 1 + r - r p_t. \quad (41)$$

**Proposition 1** *If a transitory change in taxes or transfers generates a first-period increase (decrease) in the relative price of domestic goods, the relative price must fall (rise) in the second period. Relative to the ex ante stationary equilibrium, the new stationary equilibrium (from period  $t + 1$  onwards) is characterized by a lower relative price if the price increases in the first period, and by a higher relative price if the price falls in the first period.*

In the rest of this subsection, we first discuss the effects that occur in the first period following the change in policy (the “transition” period). Then, we analyze the properties of the new stationary equilibrium that prevails from period  $t + 1$ .

### 5.1.1 Short-run effects of a temporary tax cut

Observe first that, given a constant price from  $t + 1$ , the period  $t$  consumption function of domestic savers can be written as (see equation (A.1) in the appendix):

$$c_t = \frac{\gamma \left[ (1 + r) \left( \tilde{Q}_t + Q_t^G \right) + p_t + \frac{1}{r} p_{t+1} \right]}{p_t^{1-\alpha} \left[ 1 + \frac{1}{r} \left( \frac{p_{t+1}}{p_t} \right)^{(1-\sigma)(1-\alpha\gamma)} \right]}.$$

By using (41) and  $\tilde{Q}_t = Q_t^G = 0$ , savers’ consumption in period  $t$  can be expressed as a function of only the current price, as follows:

$$c_t = \frac{\gamma \frac{1+r}{r}}{p_t^{1-\alpha} \left[ 1 + \frac{1}{r} \left( \frac{(1+r) - r p_t}{p_t} \right)^{(1-\sigma)(1-\alpha\gamma)} \right]}. \quad (42)$$

Together with the consumption function for spenders (15), this expression provides the first important result of this subsection:

**Proposition 2** *When some households are spenders, a temporary tax cut triggers a short-run increase in the relative price of domestic goods (i.e., an initial period real exchange rate appreciation).*

**Proof.** See Section B in the Appendix. ■

To facilitate discussion, we report the essential equation of the proof below:

$$\frac{dp_t}{dT_t} = \frac{\lambda(1 - \alpha\gamma)}{1 - \lambda(1 - \alpha\gamma) - (1 - \alpha\gamma)(1 - \lambda)[1 - \sigma + \alpha\gamma(\sigma - 1)]A}, \quad (43)$$

where  $A > 0$  is defined in the appendix. Note that spenders are necessary and sufficient for there to be a first-period price increase. Without spenders, the model would be fully Ricardian and transitory tax cuts would have no real effect.

Note further that the price response is not simply a weighted average of responses from two separate models, one with only spenders and one with only savers. The reason is simple: savers rationally react to the appreciation induced by rule-of-thumb consumers. Therefore, the short-run price increase is greater (smaller) if  $\sigma$  is less than (greater than) unity. When  $c$  and  $l$  are substitutes ( $\sigma < 1$ ), increased labor supply due to higher real wages contributes to increased consumption by savers, which magnifies the price response. The opposite applies when  $c$  and  $l$  are complements.

For completeness, we note that the increase in  $p$  in period  $t$  produces contemporary increases in the CPI ( $p^{1-\alpha}$ ), the nominal wage ( $p$ ) and the real wage ( $p^\alpha$ ).

The next proposition summarizes the effects on consumption.

**Proposition 3** *In the short run, a temporary tax cut (i) increases aggregate consumption and (ii) increases consumption by spenders, but (iii) has an ambiguous impact on consumption by savers.*

**Proof.** Result (i) follows from the equilibrium condition (30), since it implies:

$$\frac{dC_t}{dT_t} = \frac{\alpha\gamma}{1 - \alpha\gamma} [p_t^{\alpha-1} - (\alpha - 1)\gamma p_t^{\alpha-2}] \frac{dp_t}{dT_t} > 0. \quad (44)$$

From (15), *ex ante* consumption by savers is  $\gamma$  (recall that *ex ante*,  $p = 1$  and  $T = 0$ ), and in period  $t$ ,  $c_t^s = \gamma(p_t^\alpha + T^H/p_t^{1-\alpha})$ . Hence, we have result (ii). *Ex ante* consumption by savers can be expressed as  $\gamma \frac{1+r}{r} / (1 + \frac{1}{r})$ . Comparing this to (42) reveals that  $c_t < c$  if  $\sigma \geq 1$ , but otherwise, the effect is ambiguous. This demonstrates result (iii). ■

Note first that *aggregate* consumption unambiguously increases following a tax cut when there are spenders. Thus, the results obtained by Boskin (1988), Poterba (1988) and Blanchard and Perotti (2002) hold in our model. However, our model provides a possible explanation of the empirical finding highlighted by these authors that the

effect is typically less than the one predicted by Keynesian models. In our model, the quantitative effect depends not only on the composition of savers and spenders in the economy, but also on the interplay between the two groups:

The tax cut has an expansionary effect on spenders' consumption because of both the transfer itself and the induced increase in real wages. For savers, only the induced price effect matters. However, the relationship between this effect and the consumption decisions of savers is rather complex. A temporary increase in the CPI tends to lower consumption. When  $\sigma = 1$ , only this effect operates. If  $\sigma > 1$ , this effect is reinforced by complementarity between  $c$  and  $l$ ; higher labor supply in period  $t$  contributes to lower consumption. When  $\sigma < 1$ , savers seek to compensate their utility loss due to working more hours by increasing contemporary consumption. This counteracts the negative response of consumption to the increase in the CPI, and makes the overall response of consumption by savers ambiguous.

Thus, although the positive consumption response of spenders raises the price, the consumption response of savers is not necessarily negative. On the one hand, domestic goods are temporarily more expensive, which motivates savers to postpone consumption. However, on the other hand, wages are high, and higher labor supply and lower leisure can be compensated by higher consumption. If the latter effect dominates, the consumption response of savers magnifies the response of the spenders: "irrational" responses invite rational responses in the same direction.

The expansionary effect on  $C_t$  is greater the more households value consumption relative to leisure (i.e., the higher is  $\gamma$ ). It is also greater the more open is the economy (the larger is  $\alpha$ ). This is because, for a given increase in the relative price, the CPI increase is smaller the higher is  $\alpha$ , while the real wage increase is greater the higher is  $\alpha$ .

Perotti's (2002) empirical finding that the short-term response of production to tax cuts is negative in several countries seems counterintuitive in the context of tax cuts increasing total demand. However, the contractionary effect of a tax cut on domestic production is predicted by our model, as the following proposition makes clear.

**Proposition 4** *A transitory tax cut reduces contemporary demand for domestic goods.*

**Proof.** Differentiating (28) yields:

$$\frac{d(C_{H,t} + C_{H,t}^*)}{dT_t} = -\alpha(1-\alpha)p_t^{-\alpha-1}C_t \frac{dp_t}{dT_t} - \alpha\gamma p_t^{-2} \frac{dp_t}{dT_t} + (1-\alpha)p_t^{-\alpha} \frac{dC_t}{dT_t}. \quad (45)$$

Substituting for  $C_t$  from (30) and for  $dC_t/dT_t$  from (44)) reduces this expression to:

$$\frac{d(C_{H,t} + C_{H,t}^*)}{dT_t} = -\frac{\alpha\gamma(1-\gamma)}{1-\alpha\gamma} p_t^{-2} \frac{dp_t}{dT_t} < 0. \quad (46)$$

■

The first two terms on the right-hand side of (45) are negative. They represent expenditure switching (due to the higher price) away from domestic goods by domestic

and foreign consumers, respectively. The final term is positive and represents the effect on the demand for domestic goods due to higher aggregate consumption. Despite the stimulus to aggregate consumption, the net effect on the demand for domestic goods is unambiguously negative, as indicated by (46).

To understand the intuition behind this result, note that in equilibrium, the reduction in the demand for domestic goods is matched by a fall in production. Hence, the following corollary.

**Corollary 1** *A temporary tax cut leads to an initial reduction in equilibrium aggregate labor supply.*

**Proof.** Differentiating (29) with respect to  $T_t$  and substituting from (30) and (44) reveals that  $dN_t/dT_t$  is equal to the right-hand side of (46). ■

It may be somewhat counterintuitive that equilibrium labor supply unambiguously falls when the real wage increases (recall that the real wage is  $p_t^\alpha$ ). To understand this, assume that there are only spenders ( $\lambda = 1$ ). When spenders' disposable income increases due to the tax cut, they want to consume more and work less. Both responses raise the price and the real wage. The induced price effect limits, but does not completely reverse, the reduction in labor supply. Thus, we obtain the surprising result that in an open economy with purely Keynesian consumers, a tax cut has a short-term *contractionary* effect on output. This result emerges because, unlike most other models with Keynesian consumers, ours includes endogenous labor supply.

The response of savers' net labor supply depends on whether  $c$  and  $l$  are complements or substitutes. However, as Proposition 4 demonstrates, the overall effect of a temporary tax cut is an initial decline in labor supply and production. Furthermore, since production falls while consumption increases, the temporary tax cut generates a trade deficit in period  $t$ .

Our results differ from those in Mankiw (2000), in which the incorporation of spenders means that temporary tax cuts have large positive effects on demand. Our contrary result can be understood on the basis of three main differences with Mankiw's model. First, Mankiw develops a closed-economy model, and therefore, increases in aggregate consumption are the same as increases in domestic consumption. In our open-economy model, by contrast, the real exchange-rate appreciation leads to substitution towards foreign goods (by both domestic and foreign households). Therefore, domestic consumption may increase even though the production of domestically produced goods decreases. Second, in Mankiw's model, savers do not adjust their consumption patterns when taxes change because there is no effect on (relative) prices. In our model, by contrast, relative price changes also induce savers to respond to tax cuts. Third, labor supply is negatively affected by increased transfers in our model, whereas this effect is absent from Mankiw's analysis.

Galí *et al.* (2003) model endogenous labor supply in a framework with savers and spenders, but they do not study the effects of temporary tax cuts. However, it is easy to deduce that their model would imply an increase in production, provided monetary policy did not fully stabilize the effect. The source of this effect is sticky prices, which would

temporarily allow for an increase in real wages and a fall in firms' profits. Households would therefore be willing to supply more labor, which would be needed to increase production. In the absence of sticky prices, Galí *et al.*'s model would imply no change in production. The price level would be determined as a mark-up over nominal wages (and therefore, the real wage would also be determined). Therefore, given the labor-supply schedules of households, a joint increase in consumption (and consequently production) and labor supply (up to a first-order approximation to the equilibrium dynamics) is not possible. Hence, the increase in consumption demand from spenders is exactly offset by a decrease in demand from savers.

### 5.1.2 The new stationary equilibrium

In period  $t + 1$ , the economy reaches its new stationary equilibrium. As discussed above, this is characterized by a constant level of taxes,  $T^L = -rT^H$ , and a constant level of government debt,  $Q_{t+1}^G = -T^H$ .

A corollary of Propositions 1 and 2 is that the relative price  $p_{t+1}$  is below both the period  $t$  price  $p_t$ , and the *ex ante* stationary price. To express this in terms of the real exchange rate, the tax cut leads to an appreciation in the first period, followed by a depreciation to a new stationary equilibrium in the second period. Moreover, the depreciation is such that the real exchange rate falls below the initial stationary equilibrium value. Hence, the real exchange rate not only overshoots its long-run value, it also moves in the opposite direction. Since the relative price is less than unity from period  $t + 1$  onwards, it follows from (39) that the economy has aggregate net foreign debt ( $Q_{t+1} < 0$ ) in the new stationary equilibrium. Thus, to the extent that savers do accumulate foreign assets in period  $t$ , their asset accumulation is less than government borrowing in that period.

These observations are sufficient to determine the effects on the stationary equilibrium values for the aggregate variables in the model, which are summarized in the following proposition.

**Proposition 5** *In the long run, a transitory tax cut leads to lower aggregate consumption, but higher labor supply and higher demand for domestic goods.*

No formal proof is necessary to validate this proposition. Simply recall that in the *ex ante* stationary equilibrium,  $C = N = (C_H + C_H^*) = \gamma$ . Hence, it follows from (38) that  $C_{t+1} < C$ . Lower real wages and lower net foreign debt both contribute to lower consumption. Similarly,  $N_{t+1} > N$  follows from (37). In aggregate, the households of the economy work harder to pay off interest on their foreign debt. In equilibrium, the increase in the production of domestic goods is matched by an increase in demand. A lower relative price of domestic goods generates expenditure switching towards those goods, and the fall in domestic aggregate consumption does not completely counteract this effect. The full dynamic effects of a transitory tax cut on the model's aggregate variables can be summarized as follows: (a)  $C_t > C > C_{t+1}$ , (b)  $Y_{t+1} > Y > Y_t$ , and (c)  $(C_H + C_H^*)_{t+1} > C_H + C_H^* > (C_H + C_H^*)_t$ .

For spenders, the long-run effects of the policy are relatively straightforward. Equation (36) reveals that  $c'_{t+1} < c$ , because of negative transfers and lower real wages in the new stationary equilibrium. However, spenders increase their labor supply; see (14). Hence, the effects of the temporary tax cut on spenders are as follows:  $c'_t > c' > c'_{t+1}$  and  $n'_{t+1} > n' > n'_t$ .

For savers, there are few unambiguous effects for arbitrary values of  $\sigma$ . However, some important implications of heterogeneity can be determined by considering the special case of log utility ( $\sigma = 1$ ). Therefore, for the remainder of this subsection, we impose this assumption. Proposition 3 above shows that log utility implies a short-run decrease in real consumption for savers. Moreover, when  $\sigma = 1$ , it follows from the Euler equation (27) that  $c_{t+1} > c_t$ . To compare the *ex ante* and new stationary equilibria, we first note that, when  $\sigma = 1$ , equation (B.2) in the appendix provides the following exact expression for the relative price in period  $t$ :

$$p_{t|\sigma=1} = 1 + \frac{\lambda(1-\alpha\gamma)}{1-\lambda(1-\alpha\gamma)} T^H.$$

This expression and the consumption function (42) in (9) imply that:

$$\tilde{Q}_{t+1|\sigma=1} = \frac{1}{1-\lambda(1-\alpha\gamma)} T^H.$$

Note how spenders affect the wealth accumulation of savers. When  $\lambda = 0$ , households simply save period  $t$ 's tax cut to smooth consumption. However, with spenders, the tax cut produces a temporary price increase that raises the consumption-based real interest rate (since  $\sigma = 1$ ) that savers face. Each individual saver responds by accumulating more wealth than is implied by a pure Ricardian model.<sup>9</sup>

The previous expression and (41) in (A.1) implies that real consumption by savers in the new stationary equilibrium could be higher or lower than in the *ex ante* stationary equilibrium. Like those of spenders, savers' real wages fall from period  $t + 1$ , but unlike spenders, savers receive net asset income in the new stationary equilibrium. The log-utility function implies that consumption paths such that  $c_{t+1} > c > c_t$  or such that  $c > c_{t+1} > c_t$  are both possible for savers following a transitory tax cut.

We can use our model to discuss the distributional effects of fiscal policy. Consider the following proposition.

**Proposition 6** *Transitory tax cuts increase long-run inequality.*

This result follows from the stationary equilibrium consumption functions for savers and spenders, (34) and (36), which imply:

$$c_{t+1} - c'_{t+1} = \gamma r \frac{\tilde{Q}_{t+1}}{p_{t+1}}.$$

---

<sup>9</sup>Note, however, that total foreign assets of savers are  $(1-\lambda)\tilde{Q}_{t+1|\sigma=1} = -\frac{(1-\lambda)}{1-\lambda(1-\alpha\gamma)} Q_{t+1}^G$ . Each saver accumulates more assets than is predicted by a Ricardian model, but total private asset accumulation is below the government's debt accumulation.

This expression is clearly positive when  $\sigma = 1$ . The transitory tax cut creates incentives for spenders to accumulate financial assets, and since spenders do not save, this creates inequality in stationary equilibrium consumption. Since both types of household consume their disposable income in the stationary equilibrium, the inequality in consumption is equivalent to long-run income inequality.

## 5.2 Public spending

So far, we have ignored public spending. However, in theory (and reality) the effects of changes in public spending may be quite different from those of tax changes. Ricardian models, for instance, predict no real effects of changes in lump-sum taxes, but they do imply that changes in public spending have real effects. (For example, higher public spending typically reduces consumption according to standard forward-looking models.) We explore the effects of a one-period public spending increase. It transpires that the open-economy model with savers and spenders yields novel insights, not only when compared to standard models, but also when compared to closed-economy models with savers and spenders.

### 5.2.1 Incorporating public spending into the model

We make three assumptions. First, we restrict our attention to the log-utility model, in which  $\sigma = 1$ . Second, the government consumes domestically produced goods only. Third, private and public consumption affects the utility of private households separately. The first two assumptions are arguably the least restrictive; we have already discussed the types of effects that arise in the absence of a log-utility function, and by focusing on government consumption of domestic goods, we analyze the type of public consumption that has the richest effects because of the direct effect on domestic prices. It is straightforward to incorporate the public consumption of foreign goods into the analysis. Thus, we suggest that the third assumption is the most restrictive. The non-separability of private and public consumption may introduce important effects of fiscal policy. However, the separability assumption makes it easier to explain why our results differ from other models that incorporate spenders and savers. Thus, in this section, we opt for transparency at the cost of generality.

The incorporation of public spending into the model is straightforward. Let  $G_s$  be public demand in period  $s$ . Since all demand is for domestic goods, the value of public spending in terms of the foreign-goods basket is  $p_s G_s$

$$\sum_{s=t}^{\infty} \left( \frac{1}{1+r} \right)^{s-t} T_s = (1+r) Q_t^G - \sum_{s=t}^{\infty} \left( \frac{1}{1+r} \right)^{s-t} p_s G_s.$$

Substitution into the budget constraint of savers yields the following modified general

consumption function for these households:

$$c_t = \frac{\gamma \left[ (1+r) (\tilde{Q}_t + Q_t^G) + \sum_{s=t}^{\infty} \left( \frac{1}{1+r} \right)^{s-t} p_s (1 - G_s) \right]}{p_t^{1-\alpha} \left[ 1 + \sum_{s=t+1}^{\infty} \left( \frac{1}{1+r} \right)^{s-t} \left( \frac{p_s}{p_t} \right)^{(1-\sigma)(1-\alpha\gamma)} \right]}. \quad (47)$$

For given prices, higher government spending lowers savers' consumption. However, prices change when  $G$  changes. Note that  $G_s \leq 1$  since the maximum possible production of domestic goods in any given period is unity. (This occurs when both types of household spend all their time working.)

When there is public consumption, aggregate demand for domestic goods in equation (28) changes to:

$$C_{H,s} + C_{H,s}^* + G_s = (1 - \alpha) p_s^{-\alpha} C_s + \alpha \gamma p_s^{-1} + G_s.$$

Aggregate supply continues to be given by (29). Thus, the equilibrium relationship between aggregate private consumption and the relative price changes to:

$$C_s = \frac{\gamma}{1 - \alpha\gamma} \left[ p_s^\alpha (1 - G_s) - \alpha \gamma p_s^{\alpha-1} \right]. \quad (48)$$

This relationship can be used to show that, when there is public spending, the equilibrium trade balance is:

$$TB_s = \frac{\alpha\gamma}{1 - \alpha\gamma} [1 - p_s (1 - G_s)]. \quad (49)$$

Note that, for a given relative price, higher public spending improves the trade balance. The reason is that government consumption crowds out savers' consumption (for given prices), and since the government demands only domestic goods, this improves the trade balance. (However, again, prices change when  $G$  changes.)

### 5.2.2 A temporary increase in public spending

Without loss of generality, we assume that both  $G$  and  $T$  are zero in the *ex ante* stationary equilibrium. In period  $t$ , the government consumes the amount  $G_t$  of domestic goods. The policy is financed by foreign borrowing (i.e.,  $Q_{t+1}^G = -p_t G_t$ ), and by repaying debt with constant taxes from period  $t+1$  onwards. The government's intertemporal budget constraint implies  $T_s = T_{t+1} = -r p_t G_t \forall s > t$ .

Since the economy again reaches the new stationary equilibrium in period  $t+1$ , equation (39) implies that  $p_{t+1} = 1 + r Q_{t+1} / \alpha \gamma \quad \forall s > t$ . Therefore, the current-account equation (32) and the trade balance equation (49) imply:

$$p_{t+1} = 1 + r - r p_t (1 - G_t). \quad (50)$$

Like for the tax cut already discussed, any change in the first-period relative price is followed by an opposing change in the next period. Note also, however, that period

$t + 1$ 's reversal of the relative price is more modest than that of the tax cut. In that case,  $dp_{t+1}/dp_t = -r$ , whereas in the current case,  $dp_{t+1}/dp_t = -r(1 - G_t)$ .

Next, we use the consumption functions of both households in (48) to find the effect on the equilibrium price in period  $t$ :

$$p_t = \frac{1 - \lambda(1 - \alpha\gamma)}{1 - \lambda(1 - \alpha\gamma) - G_t}. \quad (51)$$

This solution is meaningful only if  $p_t$  is positive. Hence, we require  $G_t < 1 - \lambda(1 - \alpha\gamma)$ . Equation (51) implies that  $p_t > 1$ . In other words, a temporary increase in public spending leads to a contemporary real exchange-rate appreciation. Note that there is an appreciation whatever the value of  $\lambda$ . Unlike a cut in taxes, an increase in  $G$  leads to a price increase also if there are only savers. However, the appreciation is greater the higher the proportion of spenders. Note also that by using (51) in (50), we can show that:

$$p_{t+1} = 1 - \frac{r\lambda(1 - \alpha\gamma)G_t}{1 - \lambda(1 - \alpha\gamma) - G_t} \leq 1.$$

When there are spenders, the relative price falls below the *ex ante* level in period  $t + 1$ . If there are no spenders ( $\lambda = 0$ ), the real exchange rate depreciates to return to its *ex ante* level in the new stationary equilibrium. Hence,  $p_t > p \geq p_{t+1}$  when there is a temporary increase in  $G$ ; equality applies when  $\lambda = 0$ .

The short-run consumption response is summarized in the following proposition.

**Proposition 7** *In the short run, a temporary increase in public spending (i) has an ambiguous effect on aggregate consumption and (ii) increases consumption by spenders, but (iii) it lowers consumption by savers.*

Spenders increase consumption in period  $t$  because real wages increase. From (47) (with  $\sigma = 1$ ), consumption by savers falls in period  $t$  because of the temporary increase in the price level. In contrast to our analysis of tax cuts, we cannot say anything unambiguous about aggregate private consumption because the effects on  $C_t$  depend on the proportion of savers. This is because increased public spending increases prices even when there are no spenders, in which case, aggregate consumption falls. Thus, the smaller the proportion of savers, the more likely is private consumption to increase following an increase in public spending.

In the new stationary equilibrium, which is reached at  $t + 1$ , spenders face a lower real wage and must pay higher taxes. Therefore, consumption by spenders falls, relative to both its level in period  $t$  and its *ex ante* level. Thus, for these households,  $c'_t > c' > c'_{t+1}$ .

The consumption path for savers, on the other hand, is ambiguous when there are spenders. The Euler equation (27) implies that  $c_{t+1} > c_t$  because of the temporary price increase in period  $t$ , but whether  $c_{t+1}$  is higher or lower than the *ex ante* level is ambiguous. The reason is that, on the one hand, consumption increases since savers accumulate financial wealth (taking into account their share of public debt) and thereby yield net asset income from period  $t + 1$  onwards. However, on the other hand, consumption decreases since they face a lower real wage. Interestingly, without spenders,  $c_{t+1}$

would return to its *ex ante* level  $c$ . Recall that when  $\lambda = 0$ , the long-run relative price is unaffected (relative to the *ex ante* level) by the increase in  $G$ . In addition, it can be shown that there is no net asset accumulation by savers when  $\lambda = 0$  (gross accumulation is exactly equal to the government's debt accumulation). This leaves the stationary equilibrium consumption unaffected by the temporarily higher  $G$ . Thus, when  $\lambda = 0$ ,  $c_t < c = c_{t+1}$ .

Aggregate private consumption in the new stationary equilibrium,  $C_{t+1}$ , is lower than its *ex ante* level,  $C$ , except when  $\lambda = 0$ . Spenders reduce consumption in period  $t + 1$  and this reduction is only partially reversed by the consumption response of savers. As in the case of the relationship between  $C$  and  $C_{t+1}$  the relationship between  $C_t$  and  $C_{t+1}$  is ambiguous.

Note the contrast between our result and that of Galí *et al.* (2003), who argue that the presence of spenders is not sufficient for public spending to affect private consumption; price rigidities are also necessary. While this may be the case in a closed-economy model, it is not the case in an open-economy model, as we have shown. In their model, sticky prices generate temporary changes in the real wage, while in our open-economy model, (consumer) real wages may change in the absence of sticky prices because of changes in the real exchange rate.

The effects on labor supply and domestic production are summarized by the following proposition.

**Proposition 8** *A transitory increase in public spending leads to higher labor supply and higher domestic production in both the short run and the long run.*

Given savers' period  $t$  consumption,  $c_t = \gamma p_t^{\alpha-1}$ , in (11) it can be shown that these agents initially increase labor supply. This is a combined response to the first-period increase in the real wage and the complementarity between  $c$  and  $l$  (recall the log utility assumption). The labor supply of spenders in period  $t$  is unaffected by the increase in  $G_t$ ; see (14). There are offsetting income and substitution effects from the higher real wage on the labor supply of spenders; the real wage increase makes leisure more expensive, but it also makes spenders (feel) richer. With Cobb–Douglas preferences, the two effects cancel each other out. Thus, in the aggregate, a temporary increase in government expenditure leads to a contemporary increase in domestic labor supply and production. Note that this is contrary to the short-run response to the tax cut, which as we have already shown, generates an initial reduction in output. Note also that the result is consistent with the empirical findings of, e.g., Blanchard and Perotti (2002) and Perotti (2002).

It follows from the results in section 4 above that the labor supply of spenders increases in the new stationary equilibrium, whereas it falls for savers. Spenders work more because they have to pay permanently higher taxes, while each saver works less because he or she has accumulated net financial assets in the “transition” period. Hence, when there is a transitory increase in public spending, the labor supply paths are  $n_t > n > n_{t+1}$  and  $n'_{t+1} > n'_t = n'$  for savers and spenders, respectively.

To appreciate that the increased labor supply of spenders dominates in the aggregate, note that (37) reveals that, relative to the *ex ante* situation, production is higher in the new stationary equilibrium if the small open economy has negative net foreign assets. Equations (9) and (51) imply that:

$$\begin{aligned}
Q_{t+1} &= (1 - \lambda) \tilde{Q}_{t+1} + Q_{t+1}^G \\
&= (1 - \lambda) (p_t - 1) - p_t G_t \\
&= \frac{(1 - \lambda) G_t}{1 - \lambda(1 - \alpha\gamma) - G_t} - \frac{[1 - \lambda(1 - \alpha\gamma)] G_t}{1 - \lambda(1 - \alpha\gamma) - G_t} \\
&= -\frac{\lambda\alpha\gamma G_t}{1 - \lambda(1 - \alpha\gamma) - G_t} < 0.
\end{aligned}$$

Each saver accumulates net (consolidated) assets, but spenders' aggregate saving is less than the government's borrowing. It follows from (37) that output is higher from period  $t + 1$  onwards, relative to the *ex ante* equilibrium. Therefore, the increase in the labor supply of spenders dominates the reduction in that of savers.

The temporary increase in government expenditure thus increases production in *both* the short run and the long run. This contrasts with the effect of the tax cut analyzed earlier. Whether production is higher from period  $t + 1$  onwards than in period  $t$  depends on the distribution of savers and spenders. The higher the proportion of spenders, the more likely is  $Y_{t+1} > Y_t$ . However, both  $Y_{t+1} > Y_t > Y$  and  $Y_t > Y_{t+1} > Y$  are possible following the temporary increase in  $G_t$ .

The equilibrium effect on aggregate demand for domestically produced goods is the same as on output; relative to the *ex ante* level, demand is higher in both period  $t$  and from period  $t + 1$  onwards. It is nevertheless interesting to look at the demand effects in a slightly more disaggregated manner; i.e., how do the sources of demand adjust to fiscal policy? We use (15) to show that spenders' demand for domestic goods in period  $t$  is unaffected by the increase in  $G_t$ . The higher relative price of domestic goods and the increase in consumption lead to a zero net effect on demand for domestic goods from these households; all their increased consumption goes on foreign goods. Savers reduce their first-period consumption, which, combined with a higher relative price, leads them to reduce their demand for domestic goods. Likewise, exports fall due to the real appreciation of the exchange rate. Thus, private demand for domestic goods falls, but not by as much as public consumption. This produces a positive demand effect of higher  $G_t$  in the first period.

From period  $t + 1$ , there is no stimulus from government demand, but the relative price is lower than both the *ex ante* price and that in period  $t$ . It is also easy to show that demand from spenders falls relative to the *ex ante* and period  $t$  levels. Against this, there is higher demand from savers and foreigners (due to the depreciation), and these increases are sufficient to ensure that demand from period  $t + 1$  is above its *ex ante* level.

Equation (51) in (49) implies the following trade balance in period  $t$ :

$$TB_t = -\frac{\alpha\gamma\lambda G_t}{1 - \lambda(1 - \alpha\gamma) - G_t} \leq 0.$$

Although the government consumes only domestic goods, the increase  $G_t$  leads to a deterioration of the trade balance in period  $t$ . This is because demand from abroad falls and domestic households switch to foreign goods. Given that the economy, by assumption, has no initial foreign assets, this implies a current account deficit in period  $t$ . In the new stationary equilibrium, from period  $t+1$ , the economy runs a trade surplus that is equal to the interest payments on its foreign debt, so that the current account returns to balance.

Finally, in this section, note that in our model temporary changes in demand due to tax cuts or increased public spending have permanent effects. Changes in transfers or spending today affect the level of future transfers or spending through the public budget constraint, thereby having implications for future labor supply and relative prices. For the same reason, short-term changes in demand have permanent effects on the real exchange rate, even though our model incorporates constant returns to scale in production.

## 6 Final comments

In this paper, we have extended the savers-spenders framework of Mankiw (2000) to study fiscal policy in a small open economy. Coupled with endogenous labor supply, we have shown that this gives rise to a number of mechanisms and results that differ from those of closed-economy models, as well as from other open-economy models. In particular, tax cuts have a short-run contractionary effect and increased public spending has a short-run expansionary effect. Although consistent with recent empirical work, these results contrast with those of most other models.

While our motivation for including savers and spenders in the analysis of fiscal policy is the same as that of Mankiw (2000) and Galí *et al.* (2003), the effects of heterogeneity in our model differ from their closed-economy models. Openness allows policy to affect relative prices in the absence of price rigidities. For this reason, savers do not behave as they would have done were there no spenders; whether “irrational” spenders invite “rational” savers to respond in the same or in the opposite direction depends on features of the savers’ utility function. Thus, in general, savers may magnify or dampen responses by spenders.

## References

- Amato, J.D. and T. Laubach (2003): “Rule-of-thumb behavior and monetary policy”, *European Economic Review* 47 (5): 791–831.
- Blanchard, O. and R. Perotti (2002): “An empirical characterization of the dynamic effects of changes in government spending and taxes on output”, *Quarterly Journal of Economics* 117: 185–216.
- Boskin, M.J. (1988): “Consumption, saving and fiscal policy”, *American Economic Review* 78 (2): 401–407.
- Campbell, J.Y. and N.G. Mankiw (1989): “Consumption, income and interest rates: Reinterpreting the time-series evidence”, in O.J. Blanchard and S. Fischer (eds) *NBER Macroeconomics Annual 1989*: 185–216.
- Campbell, J.Y. and N.G. Mankiw (1990): “Permanent income, current income and consumption”, *Journal of Business and Economic Statistics* 8: 265–279
- Campbell, J.Y. and N.G. Mankiw (1991): “The response of consumption to income: A cross-country investigation”, *European Economic Review* 35 (4): 723–767.
- Dornbusch, R. (1983): “Real interest rates, home goods and optimal external borrowing”, *Journal of Political Economy* 91 (1): 141–153.
- Galí, J., J.D. López-Salido and J. Vallés (2003): “Understanding the effects of government spending on consumption”, manuscript, CREI, Universitat Pompeu Fabra, Barcelona.
- Galí, J., J.D. López-Salido and J. Vallés (2004): “Rule-of-thumb consumers and the design of interest rate rules”, *Journal of Money, Credit and Banking* forthcoming.
- Galí, J. and T. Monacelli (2004): “Monetary policy and exchange-rate volatility in a small open economy”, *Review of Economic Studies*, forthcoming.
- Mankiw, N.G. (2000): “The savers-spenders theory of fiscal policy”, *American Economic Review* 90 (2): 120–125.
- Perotti, R. (2002) “Estimating the effects of fiscal policy in OECD countries”, Mimeo, European University Institute.
- Persson, T. (1985): “Deficits and intergenerational welfare in open economies”, *Journal of International Economics*, 19 (1/2): 67–84.
- Poterba, J.M. (1988): “Are consumers forward looking? Evidence from fiscal experiments”, *American Economic Review* 78 (2): 413–418.
- Thaler, R. (1992): *The Winner’s Curse: Anomalies and Paradoxes of Economic Life*, Free Press, New York, NY, USA.
- Wolff, E.N. (1998): “Recent trends in the size distribution of households wealth”, *Journal of Economic Perspectives* 12 (3): 131–150.

## A A general consumption function for savers

We derive the general consumption function for savers, taking into account the equilibrium conditions (8), (18) and  $1 + r = \beta^{-1}$ . These conditions imply that for any period  $s > t$ :

$$c_s = c_t \left( \frac{p_s}{p_t} \right)^{\alpha(1-\gamma) - \sigma(1-\alpha\gamma)}.$$

Equations (8) and (18), together with (11), imply furthermore that the intertemporal budget constraint (20) can be written as:

$$\sum_{s=t}^{\infty} \left( \frac{1}{1+r} \right)^{s-t} p_s^{1-\alpha} c_s = \gamma \left[ (1+r) (\tilde{Q}_t + Q_t^G) + \sum_{s=t}^{\infty} \left( \frac{1}{1+r} \right)^{s-t} p_s \right].$$

Recursive substitution yields the following consumption function:

$$c_t = \frac{\gamma \left[ (1+r) (\tilde{Q}_t + Q_t^G) + \sum_{s=t}^{\infty} \left( \frac{1}{1+r} \right)^{s-t} p_s \right]}{p_t^{1-\alpha} \left[ 1 + \sum_{s=t+1}^{\infty} \left( \frac{1}{1+r} \right)^{s-t} \left( \frac{p_s}{p_t} \right)^{(1-\sigma)(1-\alpha\gamma)} \right]}. \quad (\text{A.1})$$

Note that if  $\sigma = 1$ , (A.1) simplifies to:

$$c_t = \frac{r}{1+r} \frac{\gamma \left[ (1+r) (\tilde{Q}_t + Q_t^G) + \sum_{s=t}^{\infty} \left( \frac{1}{1+r} \right)^{s-t} W_s \right]}{P_t}.$$

That is, the optimal consumption of savers is the annuity value of total consolidated discounted real wealth times the weight on consumption in the utility function.

## B Proof of Proposition 2

By substituting from (42) and (15) into (30), we obtain the following implicit relationship between  $p_t$  and  $T_t$ :

$$p_t [1 - \lambda(1 - \alpha\gamma)] = \alpha\gamma + (1 - \alpha\gamma) \left[ (1 - \lambda) \left( \frac{\frac{1+r}{r} p}{1 + \frac{1}{r} \left( \frac{(1+r)p - rp_t}{p_t} \right)^{(1-\sigma)(1-\alpha\gamma)}} \right) + \lambda T_t \right]. \quad (\text{B.2})$$

Differentiation of this expression yields:

$$\frac{dp_t}{dT_t} = \frac{\lambda(1 - \alpha\gamma)}{1 - \lambda(1 - \alpha\gamma) - (1 - \alpha\gamma)(1 - \lambda)[1 - \sigma + \alpha\gamma(\sigma - 1)]A}, \quad (\text{B.3})$$

where

$$A \equiv \frac{(1+r)}{p_t} \left\{ \frac{\frac{1+r}{r} \frac{1}{r} \left( \frac{(1+r) - rp_t}{p_t} \right)^{(1-\sigma)(1-\alpha\gamma) - 1}}{\left[ 1 + \frac{1}{r} \left( \frac{(1+r) - rp_t}{p_t} \right)^{1-\sigma + \alpha\gamma(\sigma - 1)} \right]^2} \right\} > 0. \quad (\text{B.4})$$

(Recall that  $(1+r) - rp_t = p_{t+1} > 0$ .) From (B.3),  $dp_t/dT_t > 0$  when  $\sigma \geq 1$ .

Suppose that  $\sigma < 1$  and that  $p_t$  falls when transfers increase (i.e.,  $p_t < 1$ ). From (B.3):

$$A > \frac{1 - \lambda(1 - \alpha\gamma)}{(1 - \lambda)(1 - \sigma)(1 - \alpha\gamma)^2} > 1.$$

This is a necessary condition for  $dp_t/dT_t < 0$ . From (B.4):

$$\begin{aligned} \frac{dA}{dp_t} = & \frac{1+r}{p_t^2} \left\{ \frac{\frac{1+r}{r} \frac{1}{r} \left( \frac{(1+r)-rp_t}{p_t} \right)^{(1-\sigma)(1-\alpha\gamma)-1}}{\left[ 1 + \frac{1}{r} \left( \frac{(1+r)-rp_t}{p_t} \right)^{1-\sigma+\alpha\gamma(\sigma-1)} \right]^2} \right\} \left\{ (1-\sigma)(1-\alpha\gamma) \left( \frac{1+r}{p_t} \right) \left( \frac{1+r-rp_t}{p_t} \right)^{-1} \right. \\ & \times \left[ 2 \left( \frac{1}{r} \left( \frac{1+r-rp_t}{p_t} \right)^{(1-\sigma)(1-\alpha\gamma)} + \frac{1}{r} \left( \frac{1+r-rp_t}{p_t} \right)^{2(1-\sigma)(1-\alpha\gamma)} \right) - 1 \right] \\ & \left. + \frac{1+r}{1+r-rp_t} - 1 \right\}. \end{aligned}$$

This is positive when  $p_t < 1$ . However, (B.4) shows that  $A = 1$  when  $p_t = 1$ . Since  $A$  is a continuous function of  $p_t$ , this implies that  $A \leq 1$  for any  $p_t \leq 1$ . This violates the necessary condition for  $dp_t/dT_t < 0$ , which, therefore, is not a feasible response to a tax cut.

## **WORKING PAPERS (ANO) FROM NORGES BANK 2002-2004**

Working Papers were previously issued as Arbeidsnotater from Norges Bank, see Norges Bank's website <http://www.norges-bank.no>

- 2002/1 Bache, Ida Wolden  
Empirical Modelling of Norwegian Import Prices  
Research Department 2002, 44p
- 2002/2 Bårdsen, Gunnar og Ragnar Nymoen  
Rente og inflasjon  
Forskningsavdelingen 2002, 24s
- 2002/3 Rakkestad, Ketil Johan  
Estimering av indikatorer for volatilitet  
Avdeling for Verdipapirer og internasjonal finans Norges Bank 33s
- 2002/4 Akram, Qaisar Farooq  
PPP in the medium run despite oil shocks: The case of Norway  
Research Department 2002, 34p
- 2002/5 Bårdsen, Gunnar, Eilev S. Jansen og Ragnar Nymoen  
Testing the New Keynesian Phillips curve  
Research Department 2002, 38p
- 2002/6 Lindquist, Kjersti-Gro  
The Effect of New Technology in Payment Services on Banks' Intermediation  
Research Department 2002, 28p
- 2002/7 Sparrman, Victoria  
Kan pengepolitikken påvirke koordineringsgraden i lønnsdannelsen? En empirisk analyse.  
Forskningsavdelingen 2002, 44s
- 2002/8 Holden, Steinar  
The costs of price stability - downward nominal wage rigidity in Europe  
Research Department 2002, 43p
- 2002/9 Leitemo, Kai and Ingunn Lønning  
Simple Monetary Policymaking without the Output Gap  
Research Department 2002, 29p
- 2002/10 Leitemo, Kai  
Inflation Targeting Rules: History-Dependent or Forward-Looking?  
Research Department 2002, 12p
- 2002/11 Claussen, Carl Andreas  
Persistent inefficient redistribution  
International Department 2002, 19p
- 2002/12 Næs, Randi and Johannes A. Skjeltorp  
Equity Trading by Institutional Investors: Evidence on Order Submission Strategies  
Research Department 2002, 51p
- 2002/13 Syrdal, Stig Arild  
A Study of Implied Risk-Neutral Density Functions in the Norwegian Option Market  
Securities Markets and International Finance Department 2002, 104p
- 2002/14 Holden, Steinar and John C. Driscoll  
A Note on Inflation Persistence  
Research Department 2002, 12p
- 2002/15 Driscoll, John C. and Steinar Holden  
Coordination, Fair Treatment and Inflation Persistence  
Research Department 2002, 40p
- 2003/1 Erlandsen, Solveig  
Age structure effects and consumption in Norway, 1968(3) – 1998(4)  
Research Department 2003, 27p
- 2003/2 Bakke, Bjørn og Asbjørn Enge  
Risiko i det norske betalingssystemet  
Avdeling for finansiell infrastruktur og betalingssystemer 2003, 15s

- 2003/3 Matsen, Egil and Ragnar Torvik  
Optimal Dutch Disease  
Research Department 2003, 26p
- 2003/4 Bache, Ida Wolden  
Critical Realism and Econometrics  
Research Department 2002, 18p
- 2003/5 Humphrey, David B. and Bent Vale  
Scale economies, bank mergers, and electronic payments: A spline function approach  
Research Department 2003, 34p
- 2003/6 Moen, Harald  
Nåverdien av statens investeringer i og støtte til norske banker  
Avdeling for finansiell analyse og struktur 2003, 24s
- 2003/7 Bjønnes, Geir H., Dagfinn Rime and Haakon O.Aa. Solheim  
Volume and volatility in the FX market: Does it matter who you are?  
Research Department 2003, 24p
- 2003/8 Gresvik, Olaf and Grete Øwre  
Costs and Income in the Norwegian Payment System 2001. An application of the Activity Based Costing framework  
Financial Infrastructure and Payment Systems Department 2003, 51p
- 2003/9 Næs, Randi and Johannes A. Skjeltorp  
Volume Strategic Investor Behaviour and the Volume-Volatility Relation in Equity Markets  
Research Department 2003, 43p
- 2003/10 Bjønnes, Geir Høidal and Dagfinn Rime  
Dealer Behavior and Trading Systems in Foreign Exchange Markets  
Research Department 2003, 32p
- 2003/11 Lindquist, Kjersti-Gro  
Banks' buffer capital: How important is risk  
Research Department 2003, 31p
- 2004/1 Sveen, Tommy and Lutz Weinke  
Pitfalls in the Modelling of Forward-Looking Price Setting and Investment Decisions  
Research Department 2004, 27p
- 2004/2 Andreeva, Olga  
Aggregate bankruptcy probabilities and their role in explaining banks' loan losses  
Research Department 2004, 44p
- 2004/3 Sveen, Tommy and Lutz Weinke  
New Perspectives on Capital and Sticky Prices  
Research Department 2004, 23p
- 2004/4 Bårdsen, Gunnar, Jurgen Doornik and Jan Tore Klovland  
A European-type wage equation from an American-style labor market: Evidence from a panel of Norwegian manufacturing industries in the 1930s  
Research Department 2004, 22p
- 2004/5 Holden, Steinar and Fredrik Wulfsberg  
Downward Nominal Wage Rigidity in Europe  
Research Department 2004, 33p
- 2004/6 Næs, Randi  
Ownership Structure and Stock Market Liquidity  
Research Department 2004, 50p
- 2004/7 Skjeltorp, Johannes A. and Bernt-Arne Ødegaard  
The ownership structure of repurchasing firms  
Research Department 2004, 54p
- 2004/8 Skjeltorp, Johannes A.  
The market impact and timing of open market share repurchases in Norway  
Research Department 2004, 51p
- 2004/9 Bowdler, Christopher and Eilev S. Jansen  
Testing for a time-varying price-cost markup in the Euro area inflation process  
Research Department 2004, 19p

- 2004/10 Eilev S. Jansen  
Modelling inflation in the Euro Area  
Research Department 2004, 49p
- 2004/11 Claudia M. Buch, John C. Driscoll, and Charlotte Østergaard  
Cross-Border Diversification in Bank Asset Portfolios  
Research Department 2004, 39p
- 2004/12 Tommy Sveen and Lutz Weinke  
Firm-Specific Investment, Sticky Prices, and the Taylor Principle  
Research Department 2004, 23p
- 2004/13 Geir Høidal Bjønnes, Dagfinn Rime og Haakon O.Aa. Solheim  
Liquidity provision in the overnight foreign exchange market  
Research Department 2004, 33p
- 2004/14 Steinar Holden  
Wage formation under low inflation  
Research Department 2004, 25p
- 2004/15 Roger Hammersland  
Large T and small N: A three-step approach to the identification of cointegrating relationships in time series models with a small cross-sectional dimension  
Research Department 2004, 66p
- 2004/16 Q. Farooq Akram  
Oil wealth and real exchange rates: The FEER for Norway  
Research Department 2004, 31p
- 2004/17 Q. Farooq Akram  
En effisient handlingsregel for bruk av petroleumsinntekter  
Forskningsavdelingen 2004, 40s
- 2004/18 Egil Matsen, Tommy Sveen and Ragnar Torvik  
Savers, Spenders and Fiscal Policy in a Small Open Economy  
Forskningsavdelingen 2004, 31s

**KEYWORDS:**

Rule-of-thumb consumers  
Fiscal policy  
Open economy