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# Effects of fiscal devaluation in a closed economy

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## Abstract

Fiscal devaluation works as an alternative instrument to monetary devaluation, helping countries to regain competitiveness in a monetary union. Focusing on a closed economy, this paper analyzes its effects in a dynamic framework. In the case of an increasing relative love for variety, fiscal devaluation leads to a decrease in individual consumption, an increase in the number of firms and decreases in firm markups, which are pro-competitive effects in the short run. In the long run, steady states can exist in models using non-CES utility functions, for example, quadratic linear, Stone-Geary and CARA function. The increase in the consumption tax can attract more firms entering the market, which is supported by the innovation activities, and finally help the economy reach the social optimal status.

Keyword: fiscal devaluation, relative love of variety, non-CES utility function

## 1 Introduction

After the breaking out of the financial crisis and the sovereign debt tensions, the loss of competitiveness in ‘Southern European countries’ and the following emergence of within-union external imbalances have been widely regarded as important factors contributing to the euro area crisis. To get rid of the stillness and recession of domestic economy, fiscal devaluations have been proposed as an important policy instrument to enhance a country’s competitiveness and readjust external imbalance (Puglisi, 2014). In this paper, I would like to investigate the macroeconomics consequences of a fiscal devaluation a closed economy setting.

When the domestic market is going through a slow growth, especially a weak demand, monetary devaluation is the classical way to decrease the prices of domestic products on foreign market. At the same time, the imports will be more expensive on domestic market, thus turn the demand to domestic products in both markets and the trade balance will be improved. However, in a monetary union, this devaluation is not possible. Instead, fiscal devaluation has been suggested and taken in to action. There are two types of fiscal policies, which are equivalent to exchange rate

devaluation (Farhi et al., 2014): (i) a uniform increase in import tariff and export subsidy, which is also used in non monetary union, and (ii) a VAT increase and a uniform payroll tax reduction, holding a neutral government budget constraint. Fiscal devaluation can make exports cheaper on foreign market and imports more expensive on domestic market, which is similar to the effects of a monetary devaluation. In fact, fiscal devaluation can be seen as a way that governments use to mimic a monetary devaluation, which stimulates the export and improves the trade balance. This paper will focus on the second type of fiscal devaluation policy.

With a decrease in the social contribution or payroll tax, fiscal devaluation works from decreasing labour cost of the producers, thus, firms will use more labour and increase their production, which will increase the employment rate. At the same time, the decreasing of cost will attract those less productive firms to enter the domestic market, which are not profitable enough to do so before. Moreover, some firms already existing in the market but not able to export become able to enter foreign markets as well. As the decrease of labour cost is only for domestic producing firms, while the increase in consumption tax targets on both domestic products and foreign products, this will make imports more expensive on domestic market. Together with the decrease in labour cost of domestic products on foreign markets, domestic firms will set lower final prices and win more competitiveness both at home and abroad.

Early examples can be dated back to Denmark in 1988 and Sweden in 1993 Calmfors (1998). In the case of Denmark, it has been estimated that the reform increased price competitiveness by 5 percent, measured by relative export prices Puglisi (2014). Recent standard examples are Spain, Germany and France, which are implemented after the euro crisis, aiming at getting out of the stillness. More details will be stated in the appendix.

Even though in many cases fiscal devaluation can be a choice to mimic monetary devaluation, it still holds some differences from that. Monetary devaluation does not have a direct effect on home made products in domestic market, while fiscal devaluation does. Indeed, labor subsidies financed through additional tax on consumption can also have important effects even in a closed economy. It's worth to have a look at how fiscal devaluation performs in the domestic market. In this research, I will focus on the closed economy case, thus isolate the effects on domestic producers and consumers from international trade considerations.

I set a two-sector economy in my model, one is the producing sector, which produces consuming products using traditional technology, and the other sector is the innovation sector, which creates new varieties that can be bought by new firms to produce in the next period. The innovation sector is facing a competitive market, all the varieties will be bought by the producing sector. For simplification, I assume the new varieties using different technology only use labour to produce, and the labour demand is same across each varieties. Thus, the producing firms are asymmetric. All the varieties disappear after the current period. In the next period, the existing varieties are those created by the innovation sector in the last period. At the same time, the producing sector is facing a monopolistic market where the consumers

have relative love for varieties, so that each firm has its market power and can gain benefits from its markup.

Monopolistic competition structure, which can be dated back to Chamberlin and Robinson in 1933, allows the existence of markup, which keeps attracting new firms to enter the market. Dixit and Stiglitz (1977) analyzes the optimum product diversity, focusing on the trade-off between the number of varieties and the consumption per variety, which helps to understand how fiscal devaluation can affect this trade off. Besides, another classic reference of my paper is Krugman (1979), which includes the international trades under the monopolistic framework in an open economy.

As to the innovation sector, Grossman and Helpman (1991) distinguished innovations into process innovation and product innovation. The former is concerned with innovations that reduce the costs of production of the existing products, which is also called the intensive margin. And the later refers to the introduction of new products, which can be regarded as extensive margin innovation. This paper focuses on the second one. Besides, Acemoglu (1999) also claimed that economic growth can take place as the by-product of knowledge spillovers, which is a consequence of purposeful investments by firms and individuals. This can be reflected by the relationship between the number of firms in different terms. Number of varieties in the current period is positively related to the one in the preceding one, this means the more the varieties are in last period, the more efficient the innovation will be.

Since there is positive externality of innovation (the new innovated varieties spread the new knowledge to the old varieties, thus increase the aggregate level of the total productivity period after one period. In return, the number of the existing firms have a positive effect on the number of varieties in next period), social return of RD investment is higher than the private return. The subsidy to the RD sector, which is usually a part of fiscal devaluation, is efficient to close the gap and finally improve the welfare for all.

In my model, the implement of fiscal devaluation consists of a tax on the products using traditional technology, and a subsidy (decrease or a negative tax) on labour used in the production sector but also in the innovation sector. Under this structure, this paper steps out to first look at the consequence of fiscal devaluation on the number of varieties. Via affecting the prices (especially the markup) of the new varieties, fiscal devaluation can affect the size of the innovation. To understand how fiscal devaluation can augment the number of firms by subsidizing labor used in innovation, the consequences of fiscal devaluation on markups (prices) is a crucial point.

When we turn to the consumers part, two items need to be pointed out. One is the choice of utility function. Zhelobodko et al. (2012) points out that markups are exogenous under CES utility structure. Therefore, to match the monopolistic market structure and analyze the changing of markup, it seems interesting to assume that household's preferences are described by a non-CES utility function, which allows for variable and endogenous markups. Why markup is not constant? With fiscal devaluation, even though the labour subsidy can decrease the cost of firms, usually

this decrease will not totally transfer to the decrease in final prices, which means that the markup can change among different varieties and periods. As to how much the decrease will be, each firm makes its own decision depending on their own cases, and this is also more frequently observed in reality.

Relative love for variety is an interesting concept that logically links the characters of consumers' utility to the market power of the firms under a monopolistic frame. Relative love for variety describes the consumers' preference for differentiated consumption basket, or more varieties.

Zhelobodko et al. (2012) defines the relative love for variety as the inverse of elasticity of substitution across varieties, and they also shows that relative love for variety is not only the inverse of the price elasticity, but also the firm's markup. When the substitution elasticity is high across varieties, it means the varieties are comparatively similar to each other, consumers don't have significant preference between the different varieties. Thus, the consumption per variety is comparatively sensitive to the change of its price, or we can say the demand-price elasticity is high so that firms do not have a strong market power. This case is what we call consumers have a low relative love for variety.

In this paper I take the case that the relative love for variety is increasing with intensive margin (consumption per variety), which can be verified by Peltzman (2000) and Carbonnier (2006). This will perform a pro-competitive effect. Starting from the case individual consumption of each variety is high, because of the trade-off between the number of varieties and consumption per variable, it means there are only few firms producing different varieties, the substitution elasticity is low between each other, and each firm enjoys a relative strong market power, thus leads to a high markup. At the same time, consumers are showing a strong will to have a more differentiated consumption basket so they are not that much sensitive to the price, the price- demand elasticity is low. Here high markup meets with a high relative love of variety. Both of them will continuously attract more firms entering the market, leading to a lower market price, which is a pro-competitive effect. What's needed to be pointed out is that the relative love for variety can also decreases with consumption per variety, which generates an anti-competitive effect. In other words, instead of the firms' collusive behaviors, an anti- competitive effect may just result from the characteristics of the consumers' preferences.

Using linear demand system with horizontal product differentiation, Melitz and Ottaviano (2008) generate an endogenous distribution of markups across firms that responds to the toughness of competition in a market—the number and average productivity of competing firms on that market. In this paper, I also consider a linear quadratic utility function but, unlike Melitz and Ottaviano (2008), without cross-price effect. To make complementary analysis, I also introduce Stone-Geary, Generalized-CES and CARA utility functions.

In the short run, the number of the firms is fixed, while the prices and wage are flexible. Using our utility function under the assumption of an increasing relative love for variety, the individual consumption and mark-up are always decreasing in the consumption tax, which is a pro-competitive case. While the change of price is

influenced by markup effect and basic effect and it can not be clearly clarified.

In the long run, the values of parameters and choices of utility functions can lead to different outcomes. When we consider about the local stability, holding the trade-off between the number of varieties and the consumption per variety, in the cases where the steady state exists, we will find that consumption per variety is always decreasing in consumption tax. This means that the channels through which the tax can affect the macro variables in the short run also work in the long run. Such pro-competition case can be explained by the entry of new firms due to the innovation activities.

## 2 The model

### 2.1 Consumers

We assume that each person lives only one period and will have only one child so that there are always  $L$  consumers (who are also workers) in every period. This is one difference from Grossman and Helpman and other papers cited above, which all consider about infinitely lived agents models.

Each consumer provides only one unit of labour in one period. There exists a mass  $N_t$  of firms, which supply differentiated commodities indexed by  $\omega \in [0, N_t]$ .  $p_t(\omega)$  and  $x_t(\omega)$  are the price and the consumption per worker of the commodity  $\omega \in [0, N_t]$ .  $u(x_t(\omega))$  is the individual utility of a single type of commodity. As mentioned before, we assume  $u(x_t(\omega))$  to be a non-CES function.

The consumers not only care about their own consumption, but also care about the bequest they can give to the next generation, which is denoted by  $a_{t+1}$ . The bequest will take form of investing in the innovation sector and their children owns the new firms and can benefit from the profits in next period.

The Utility Function is

$$(1 - \gamma) \ln V_t + \gamma \ln a_{t+1}$$

where

$$V_t = \int_0^{N_t} u(x_t(\omega)) d\omega$$

where  $\gamma$  represents the degree of altruism of the parent towards his child.

And the Budget Constraint writes

$$\int_0^{N_t} p_t(\omega) x_t(\omega) d\omega + a_{t+1} = (1 + r_t) a_t + w_t$$

$w_t$  is the wage rate. On the left side of the budget constraint is the expenditure of the consumer and the asset which he wants to give to his child. On the right side is the sum up of the current value of the bequest he gets from his parent  $(1 + r_t)a_t$

and his own labour income of this period  $w_t$ .  $r_t$  is the real rate of return in period  $t$  on assets given by the parent. To maximize his utility, we build the Lagrangian function using  $\lambda_t$  as the Lagrangian multiplier:

$$\mathcal{L} = (1 - \gamma) \ln V_t + \gamma \ln a_{t+1} - \lambda_t \left( \int_0^{N_t} p_t(\omega) x_t(\omega) d\omega + a_{t+1} - (1 + r_t) a_t - w_t \right)$$

The FOCs are:

With respect to  $x_t(\omega)$ :

$$\frac{1 - \gamma}{V_t} u'(x_t(\omega)) = \lambda_t p_t(\omega)$$

(1)

With respect to  $a_{t+1}$ :

$$\frac{\gamma}{a_{t+1}} = \lambda_t \tag{2}$$

Thus we can get:

$$(1 - \gamma) \frac{u'(x_t(\omega))}{p_t(\omega) V_t} = \frac{\gamma}{a_{t+1}} \tag{3}$$

## 2.2 Firms

We introduce the fiscal instruments  $\tau_t^c$  and  $\tau_t^w$ .  $\tau_t^c$  is the consumption tax rate, of which a typical example is the VAT.  $\tau_t^w$  is the labour tax rate which in reality corresponds to social security contributions. For the producers, the price of each commodity is  $(1 - \tau_t^c)p_t$  and the cost of each product is  $(1 + \tau_t^w)w_t$ . As there are  $L$  consumers, each of them consuming  $x_t(\omega)$  of commodity  $\omega$ , and one unit of labour providing one unit of output, we can express the profits of the firm who produces commodity  $\omega$  as:

$$\pi_t = (1 - \tau_t^c)p_t(\omega)x_t(\omega)L - (1 + \tau_t^w)w_t x_t(\omega)L \tag{4}$$

The monopolistic producers maximize their profits subject to the demand function, which was deduced from the first-order conditions of the consumers equation(1), which is equivalent to (demand function)

$$p_t(\omega) = \frac{1 - \gamma}{V_t \lambda_t} u'(x_t(\omega)) \tag{5}$$

To maximize the profits of the firms, let us replace the price in the profit function by its expression given by the latter equation. Then we set the FOC of the producer's profits with respect to  $x_t(\omega)$ :

$$[(1 - \tau_t^c)p_t(\omega) - (1 + \tau_t^w)w_t]L + (1 - \tau_t^c)\frac{1 - \gamma}{V_t\lambda_t}u''(x_t(\omega))Lx_t(\omega) = 0$$

We denote the concept of relative love for variety by

$$r_{u(x)} = \frac{-xu''(x)}{u'(x)}$$

As we assume that those firms use same technology, which implies that the labour demand is the same. Here same consumption across varieties is the consequence of the symmetric firms. The relative love for variety (RLV) is the inverse of the elasticity of substitution across varieties (Zhelobodko et al, 2011). The preceding equation can be rewritten as

$$\frac{(1 - \tau_t^c)p_t - (1 + \tau_t^w)w_t}{(1 - \tau_t^c)p_t} = \frac{-u''(x_t)x_t}{u'(x_t)}$$

With the definition of the mark-up  $m$

$$m = \frac{(1 - \tau_t^c)p_t(\omega) - (1 + \tau_t^w)w_t}{(1 - \tau_t^c)p_t(\omega)}$$

and the definition of the relative love for variety

$$r_{u(x)} = \frac{-xu''(x)}{u'(x)}$$

one gets

$$m = r_u (< 1)$$

It is verified that the mark-up of a firm is equal to the relative love for variety.

Notice that positivity of price and wage implies that the mark-up  $m$  is lower than one. So the relative love for variety has also to be lower than one at the equilibrium. From the definition of markup, we can have:

$$(1 - \tau_t^c)p_t[1 - m(x_t)] = (1 + \tau_t^w)w_t \tag{6}$$

Using the demand function,

$$p_t = \frac{1 - \gamma}{V_t\lambda_t}u'(x_t)$$

we can get

$$u'(x_t)[1 - m(x_t)] = \frac{1 + \tau_t^w}{1 - \tau_t^c} \frac{w_t V_t \lambda_t}{1 - \gamma} \tag{7}$$



**Proposition 1** *Let's assume the existence of a solution in  $x$  to equation(7), that is:  $\lim_{x \rightarrow 0} u'(x_t)[1 - m(x_t)] > A_t$ , and there exists  $\bar{x}$ , such that  $u'(\bar{x})[1 - m(\bar{x})] < A_t$ , where  $A_t = \frac{1 + \tau_t^w}{1 - \tau_t^c} \frac{w_t V_t \lambda_t}{1 - \gamma}$ . Under the condition  $(2u''(x_t) + u'''(x_t)x_t) < 0$ , all firms produce the same quantity  $x_t$  at the same price  $p_t$ . The equilibrium is unique and symmetric.*

All firms supply the same quantity of output at the same price, it is required that equation(7) has only one solution in  $x$ . The profits function need to be strictly concave, which means its second order derivative of the profits equation(4) is negative.

Second order condition with respect to  $x_t$  is:

$$(1 - \tau^c) \frac{1 - \gamma}{V_t \lambda_t} (2u''(x_t) + u'''(x_t)x_t) < 0$$

Since  $(1 - \tau^c) \frac{1 - \gamma}{V_t \lambda_t}$  is positive, the concavity requirement of the profits function turns into

$$(2u''(x_t) + u'''(x_t)x_t) < 0$$

## 2.3 R&D sector

Households invest in the R&D sector to build up new blueprints. These new blueprints do not enter the producing sector in the current term, but will become obsolete in the next period. Producing firms also only exist for one period. In next period, firms will buy new varieties from these new blueprints. Thus, new blueprints can make technological progress and the spillover of the new blueprints leads to economic growth. We assume that the law of motion of the mass of blueprints is

$$N_{t+1} = \eta L_t^R N_t \tag{8}$$

Here  $L_t^R$  is the labour employed in the R&D sector and the parameter  $\eta$  is the innovation efficiency of labour in the R&D sector.

Labour cost in the R&D sector is  $(1 + \tau_t^w)w_t L_t^R$ . Then the current value of the cost of one new blueprint  $\Gamma_t$  is

$$\Gamma_t = \frac{(1 + \tau_t^w)w_t L_t^R}{N_{t+1}}$$

The current value of future profit made by a new blueprint is  $\Gamma_t = \frac{\pi_{t+1}}{1 + r_{t+1}}$

Free entry assumption in the R&D sector implies equality between the profit and the cost of a new blueprint. So we need:

$$\Gamma_t = \frac{\pi_{t+1}}{1 + r_{t+1}} = \frac{(1 + \tau_t^w)w_t L_t^R}{N_{t+1}} \tag{10}$$

## 2.4 Equilibrium

To complete the equilibrium in period  $t$ , we need market clearing conditions on both the labour market and the financial market.

Equilibrium on labour market requires labour supply to be allocated in producing sector and RD sector:

$$L = LN_t x_t + L_t^R$$

$$L_t^R = L(1 - N_t x_t) \quad (11)$$

Equilibrium on the financial market implies that savings of generation  $t$  for bequests  $La_{t+1}$  is invested in the new blueprints,

$$La_{t+1} = N_{t+1}\Gamma_t$$

which is equivalent to

$$La_{t+1} = (1 + \tau_t^w)w_t L_t^R$$

The parents give their bequests by investing in new blueprints and their children can hold the shares of the new blueprints and enjoy the profits.

**Proposition 2** *Under the normalization  $w_t = 1$ ,  $x_t$  and  $N_t$  are linked through a static relationship:*

$$1 - N_t x_t = \frac{u(x_t)N_t\gamma}{(1 - \tau_t^c)(1 - \gamma)u'(x_t)[1 - m(x_t)]}$$

By combining the equilibrium of the two markets, we get:

$$a_{t+1} = (1 + \tau_t^w)w_t(1 - N_t x_t) \quad (12)$$

At the beginning of period  $t$ , the number of firms  $N_t$  is given and resulted from the new blueprints of the last period.

Since the firms are symmetric,

$$V_t = u(x_t)N_t$$

For given  $\tau_t^w$  and  $\tau_t^c$ , we can deduce a relationship between  $x_t$  and  $a_{t+1}$  with equation(2) and equation(7)

we get

$$u'(x_t)[1 - m(x_t)] = \frac{1 + \tau_t^w}{1 - \tau_t^c} \frac{u(x_t)N_t\gamma}{(1 - \gamma)a_{t+1}} \quad (13)$$

Combining equation(11) and equation(13), we can get

$$u'(x_t)[1 - m(x_t)] = \frac{1}{1 - N_t x_t} \frac{u(x_t)N_t\gamma}{(1 - \tau_t^c)(1 - \gamma)}$$

which is equivalent to

$$1 - N_t x_t = \frac{u(x_t) N_t \gamma}{(1 - \tau_t^c)(1 - \gamma) u'(x_t) [1 - m(x_t)]} \quad (14)$$

We suppose that the government holds neutral budget constraint, so that we can get the relationship between  $\tau_t^c$  and  $\tau_t^w$

$$\tau_t^c p_t N_t x_t L + \tau_t^w w_t L = 0 \quad (15)$$

We assume that the government chooses  $\tau_t^c = \tau^c$  in every period. Then we can get  $\tau_t^w$  from equation(15) (using the normalization assumption  $w_t = 1$ ):

$$\tau_t^w = -\tau^c p_t N_t x_t \quad (16)$$

Our discussion of the influences of the fiscal devaluation turns into a discussion of the changes of only one of the instruments:  $\tau^c$ .

## 2.5 Short run effects of fiscal devaluation

In our model, the fiscal devaluation takes the form of an increase in the consumption tax. In the short run, the number of firms is fixed, while the individual consumption  $x$  is variable.

**Assumption 1**  $m(x)$  is increasing in  $x$ . Markup is increasing in individual consumption.

This widely observed case shows that when an individual firm faces an increasing demand, it can reserve a stronger market power, reflected by a larger markup.

A. Effect on  $x_t$

From equation(14), we get

$$1 - N_t x_t - \frac{u(x_t) N_t \gamma}{(1 - \tau_t^c)(1 - \gamma) u'(x_t) [1 - m(x_t)]} = 0$$

We set this as a function:

$$F(x_t, \tau_t^c) = 0$$

Because  $\tau_t^c$  is at the lower side of  $F$  with 2 negative signs before,  $F$  is decreasing in  $\tau_t^c$ .  $u(x_t)$  is increasing in  $x$ ,  $u'(x_t)$  is the marginal utility which is decreasing in  $x$ ,  $m(x)$  is increasing in  $x$ , so  $1 - m(x_t)$  is decreasing in  $x$ . Altogether,  $F$  is decreasing in  $x$ . Now we have  $F$  decreases both in  $x$  and  $\tau^c$ . We rewrite  $F(x_t, \tau_t^c) = 0$  into  $x(\tau_t^c) = 0$ , thus we can get

$$\frac{dx}{d\tau_t^c} = -\frac{\frac{dF}{d\tau_t^c}}{\frac{dF}{dx}} < 0$$

$x$  is decreasing in  $\tau_t^c$ . Increasing the consumption tax rate will lead to a decrease in the individual consumption of each commodity. When the tax is declared, producers will try to increase the prices to cover it, and consumers have the intuition that the prices will increase, so they prefer to press their demand, so that the individual consumption decreases in this way.

#### B. Effect on the mark-up

In the three cases I will talk about later,  $m(x)$  is always increasing in  $x$ , and  $x$  is decreasing in  $\tau_t^c$ , we can get the conclusion that  $m(x)$  decreases with  $\tau_t^c$ . Increasing the consumption tax rate leads to a decrease in mark-up. This is what we sometimes observe in reality. This is because the producers are facing a decreasing demand and they could not totally transfer the tax pressure to the consumers. Also, the cutting off of the social security contribution is not enough to compensate the consumption tax increase, so that producers have to absorb a part of the taxation.

#### C. Effect on the price

From equation(6), we can get

$$p_t = \frac{1 + \tau^w}{1 - \tau^c} \frac{1}{1 - m(x_t)}$$

Using the budget constraint of the government, we deduce

$$p_t = \frac{1 - \tau^c p_t N_t x_t}{1 - \tau^c} \frac{1}{1 - m(x_t)}$$

This reflects two different channels how consumption tax could influence the price. One is  $\frac{1}{1 - m(x)}$ , the markup effect. If the government increases the consumption tax, it will lower the firms' benefits, so the firms have the motivation to increase the consumer price. From the earlier analysis, how  $m(x)$  reacts depends on how  $\tau_t^c$  affects  $x_t$ . From what we have already known,  $x_t$  decreases in  $\tau_t^c$ , so  $m(x)$  decreases in  $\tau_t^c$ . This corresponds to the case that there are more competitions between the firms, which is a pro-competitive effect. So here price decreases with  $\tau_t^c$ .

The other one is the fiscal basis effect,  $\frac{1 - \tau^c p_t N_t x_t}{1 - \tau^c}$ . When  $p_t N_t x_t > 1$ ,  $\frac{1 - \tau^c p_t N_t x_t}{1 - \tau^c}$  decreases with  $\tau^c$ , it has the same effect like the markup effect. When  $p_t N_t x_t < 1$ ,  $\frac{1 - \tau^c p_t N_t x_t}{1 - \tau^c}$  increases with  $\tau^c$ , which is opposite to the markup effect. These two channels may have opposite effects on the price, however, we have no explicit way to say which is stronger. So the effect of consumption tax on the price is not clear in the short run.

### 3 Dynamics of $N_t$ and $x_t$

Along the dynamics, number of firms is changing due to the innovation and there exists a tradeoff between individual consumption and number of varieties.

From equation(8) and equation(11), we can get,

$$\frac{N_{t+1}}{N_t} = \eta L (1 - N_t x_t)$$

In order to analyze dynamics, from Proposition 2, we describe the static relationship between  $N_t$  and  $x_t$  in the following way:

$$N_t = N(x_t) = \frac{1}{x_t + \frac{u(x_t)}{u'(x_t)(1-m(x_t))} \frac{\gamma}{1-\gamma} \frac{1}{1-\tau^c}} \quad (17)$$

Let's have a look at equation (17), we can find that  $u(x_t)$  increases in  $x_t$ ,  $u'(x_t)$  decreases in  $x_t$ , and  $1 - m(x_t)$  decreases in  $x_t$  under Assumption 1, so that  $N(x_t)$  is always decreasing in  $x_t$ ,  $N'(x_t) < 0$ . And the dynamics of  $N_t$  can be described like this:

$$N(x_{t+1}) = \eta L (1 - N(x_t)x_t) N(x_t) \quad (18)$$

From Proposition 2, we have

$$1 - N_t x_t = N_t \frac{\gamma}{(1-\gamma)(1-\tau_t^c)} \frac{u(x_t)}{u'(x_t)(1-m(x_t))}$$

we set

$$\Psi = \frac{x_t u'(x_t)(1-m(x_t))}{u(x_t)}$$

equation(14) turns into

$$1 - N_t x_t = 1 + \frac{\frac{\gamma}{(1-\gamma)(1-\tau_t^c)} \frac{u(x_t)}{x_t u'(x_t)(1-m(x_t))}}{\frac{\gamma}{(1-\gamma)(1-\tau_t^c)} \frac{1}{\Psi(x_t)}}$$

so that

$$N_t x_t = \frac{1}{1 + \frac{\gamma}{(1-\gamma)(1-\tau_t^c)} \frac{1}{\Psi(x_t)}}$$

**Lemma 1** *A steady state  $x^*$  is characterized by the equation:*

$$\Psi = \frac{x_t u'(x_t)(1-m(x_t))}{u(x_t)} = BM(\text{short for benchmark})$$

From equation (18)

$$N(x_{t+1}) = \eta L (1 - N(x_t)x_t) N(x_t) \\ = \eta L \frac{N(x_t)\gamma}{\gamma + (1-\gamma)(1-\tau_t^c)\Psi(x_t)}$$

If  $N_t$  is decreasing and converges to the steady state,

$$\eta L (1 - N(x_t)x_t) < 1$$

which means,

$$N(x_t)x_t > 1 - \frac{1}{\eta L} \\ \frac{1}{1 + \frac{\gamma}{(1-\gamma)(1-\tau_t^c)} \frac{1}{\Psi(x_t)}} > 1 - \frac{1}{\eta L} \\ \Psi(x_t) = \frac{x_t u'(x_t)}{u(x_t)} [1 - m(x_t)] > \frac{\eta L - 1}{1 - \tau^c} \frac{\gamma}{1 - \gamma} = BM(\tau^c)$$

If

$$\eta L(1 - N(x_t)x_t) > 1$$

which equals

$$\Psi(x_t) < \frac{\eta L - 1}{1 - \tau^c} \frac{\gamma}{1 - \gamma} = BM(\tau^c)$$

number of firms will increase to the steady state. And steady states  $x$  are characterized by:

$$\begin{aligned} N(x_{t+1}) &= \eta L(1 - N(x_t)x_t)N(x_t) \\ &\Leftrightarrow 1 = \eta L(1 - N(x)x) \\ &\Leftrightarrow N(x)x = 1 - \frac{1}{\eta L} \end{aligned}$$

**Definition 1** 1) Let  $n$  be the number of steady states. 2) Let us index these steady states in an increasing order, that is  $x_i^* < x_j^*$  if  $i < j$ . 3) Let us also define  $D(x^*)$ , the set of values of  $x$  which contains all the values of  $x$  that are higher than the former steady state and lower than the next one. ( $D(x^*)$  contains all the values inside the interval of 2 adjacent  $x^*$ )

**Definition 2** Let us define the 3 following types of steady states: Type 1:  $\Psi'(x^*) < 0$ . Type 2:  $\Psi'(x^*) > 0$ . Type 3:  $\Psi'(x^*) = 0$ .

**Proposition 3** Consider a type 1 steady state  $x^*$ ,  $x_t \in D(x^*) \Leftrightarrow x_t$  converges monotonously towards  $x^*$ , type 1 steady state is the only type which is local stable.

Since  $N'(x_t) < 0$  is always true, for any type 1  $x^*$ , we have

(1)  $x_t \in D(x^*) \cap (0, x^*) \Leftrightarrow \Psi(x) > BM$ , in this interval,  $N_t$  is decreasing,  $x_t < x_{t+1} < x^*$

(2)  $x_t \in D(x^*) \cap (x^*, \infty) \Leftrightarrow \Psi(x) < BM$ , in this interval,  $N_t$  is increasing and  $x_t > x_{t+1} > x^*$

In this interval,  $x$  larger or smaller than the steady state will converge to it from different direction, while the case for type 2 steady state will be the opposite.  $x_t$  will explode towards to different directions. Thus, type 1 steady state is the only local stable one.

From this part, I will introduce different types of utility functions to have a further talk on the reactions of macrovariables.

- Stone-Geary case

$$\begin{aligned} u(x) &= \ln(a+x) - \ln a \\ u'(x) &= \frac{1}{a+x}, u''(x) = -\frac{1}{(a+x)^2} \\ m(x) &= \frac{x}{a+x}, u''' = \frac{2}{(a+x)^3} \\ \Psi &= \frac{x}{a+x} \frac{a}{a+x} \frac{1}{\ln(a+x) - \ln a} \end{aligned}$$

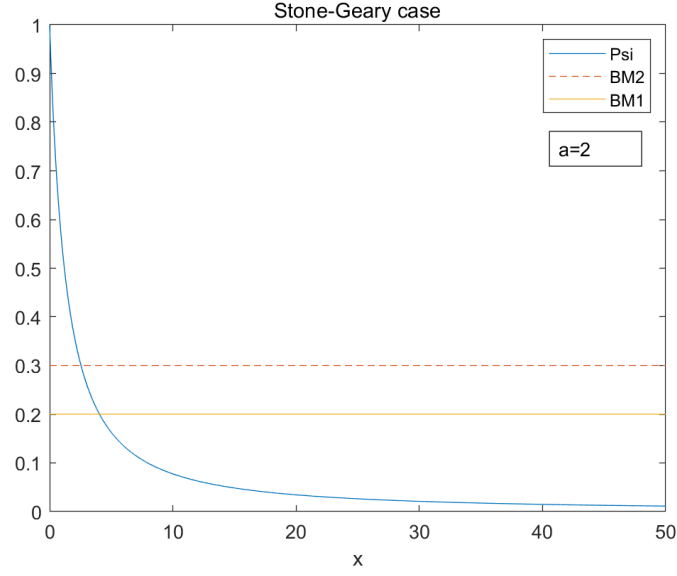


Figure 1: Stone-Geary

- Quadratic linear case

$$u(x) = a + bx - \frac{c}{2}x^2$$

$$u'(x) = b - cx, u''(x) = -c, u'''(x) = 0, m(x) = \frac{cx}{b - cx}$$

$$\Psi = \frac{x(b - cx)}{a + bx - \frac{c}{2}x^2} \frac{b - 2cx}{b - cx} = \frac{x(b - 2cx)}{a + bx - \frac{c}{2}x^2}$$

- CARA case

$$u(x) = 1 - e^{-ax}, a > 0$$

$$u'(x) = ae^{-ax} (> 0), u''(x) = -a^2e^{-ax} (< 0)$$

$$m(x) = ax, u'''(x) = a^3e^{-ax}, \Psi = \frac{xae^{-ax}}{1 - e^{-ax}}(1 - ax)$$

The above three cases share some common points. From proposition 3, we know that only type 1 steady state is locally stable, and it appears only at the downward slope of the curve. In the graphs, we can see that the benchmark line goes across the  $\Psi$  curve in all the three cases. In Stone-Geary case,  $\Psi$  is always decreasing with  $x$ , there is only one steady state, which is also a type 1 steady state. While in quadratic linear case,  $\Psi$  increases first then decreases. If the benchmark line goes across the  $\Psi$  curve, there will be two possible steady state, the left one is of type 2 and the right one is type 1. In CARA case, there at least exists one type 1 steady state, which is the left crossing point. Since the  $\Psi$  is converging to 0, the right crossing point may not exist, but it will be a type 2 (non stable) one even if it exists. We need to point out here the choosing of parameters will affect the height of the benchmark

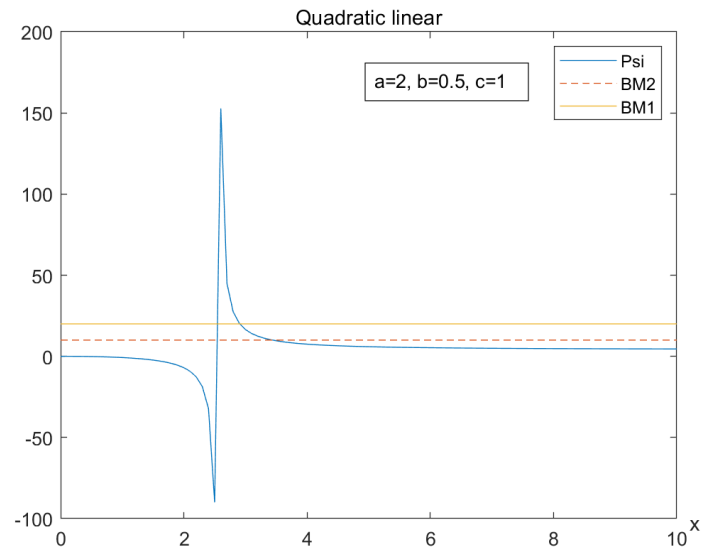


Figure 2: Quadratic Linear

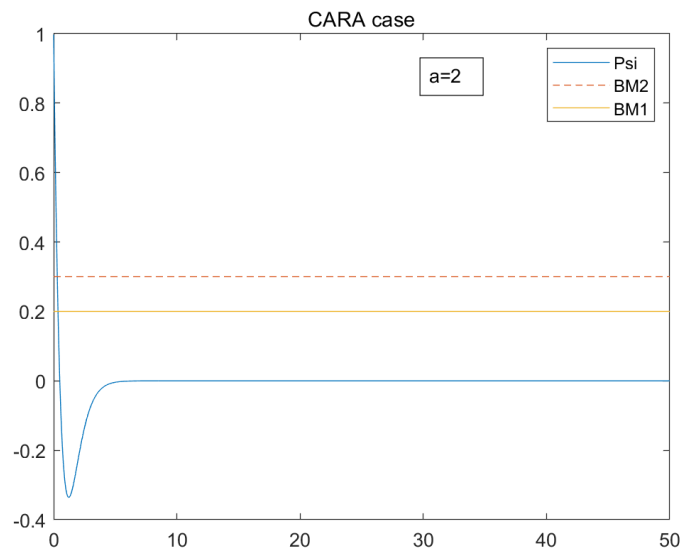


Figure 3: CARA



line, which leads to a disappearance of the steady state. This means the existence of steady state in the long run depends on the characteristics of the consumers' utilities and the value of the parameters, but we can also say that the steady state widely exists in many cases.

During the dynamics towards the steady state, if  $\Psi(x_t)$  is smaller than the benchmark,  $N_t$  is increasing, we will have a growing number of firms in the market before we reach the steady state, which will provide more choices to the consumers and also reflects the growing of the innovation activities. On the other hand, if  $\Psi(x_t)$  is larger than the benchmark, the number of firms in the market will decrease as time goes by, fewer firms will exist in the market at the steady state, but each of them enjoys a comparatively larger market share. This shows an anti-competitive characteristic.

Let's have a look at how the fiscal devaluation can affect the benchmark. From the expression of the benchmark,  $BM(\tau^c)$  is increasing with  $\tau^c$ . When we implement a fiscal devaluation with an increase in the consumption tax, this benchmark will increase at the same time. This means, in the cases where the steady state exists, when the  $\tau^c$  increases, the curve of  $BM(\tau^c)$  will shift upward, thus leading to a smaller  $x$  and larger  $N$  in the long run. The implementation of fiscal devaluation can make the market more competitive.

## 4 Effects of fiscal devaluation on markup and price

### 4.1 Long-run effects

In the long run, both  $x$  and  $N$  are variable. In the case of Stone-Geary, quadrati-linear and CARA utility functions, steady state may exist. In all these cases,  $x$  is always decreasing with  $\tau^c$  and  $N$  increases at the same time. Similar to the short run,  $m$  is decided by  $x$ . And in these cases, markup is always increasing with individual consumption. As  $x$  decreases, markup always decreases. These are the same with the short run case.

As to the price,

$$p_t = \frac{1}{(1 - \tau_t^c)(1 - m(x)) + \tau_t^c(1 - \frac{1}{\eta L})}$$

both basis effect and markup effect exist. The way price reacts to the implementation of an increase in consumption tax is quite similar to the short run, and we still cannot declare whether the price will increase or not.

Generally speaking, the channels of fiscal devaluation influencing individual consumption, markup and price also work in the long run and lead to similar outcomes. What is different is that the number of firms is increasing, due to the innovation activities. The market shows a pro-competitive phenomenon.

## 4.2 Welfare

After talking about the above 4 macrovariables, I turn to have a look at how the social welfare will be influenced by the consumption tax, which is measured by total utilities.

$$\text{Max}(1 - \gamma) \ln V + \gamma \ln a$$

where

$$V = N(x(\tau^c))u(x(\tau^c)) = \frac{u(x(\tau^c))}{x(\tau^c)}(1 - 1/\eta L)$$

FOC:

$$\frac{u'(x)}{x} - \frac{u(c)}{x^2} = 0$$

which equals to

$$\frac{x^* u'(x^*)}{u(x^*)} = 1$$

At steady state,  $x$  is the solution of

$$\Psi(x_t) = \frac{x_t u'(x_t)}{u(x_t)} [1 - m(x_t)] = \frac{\eta L - 1}{1 - \tau^c} \frac{\gamma}{1 - \gamma} = BM(t^c)$$

A steady state equilibrium is social optimal if and only if the upper requirement is satisfied, that is

$$\frac{\eta L - 1}{1 - \tau^c} \frac{\gamma}{1 - \gamma} = 1 - m(x^*)$$

Then we derivate  $V$  over  $x$ ,  
in quadratic linear case,

$$\frac{dV}{dx} = (1 - 1/\eta L) \frac{u'(x)x - u(x)}{x^2} = -\frac{a + c/2x^2}{x^2} < 0$$

in Generalized CES,

$$\frac{dV}{dx} = (1 - 1/\eta L) \frac{u'(x)x - u(x)}{x^2} = \frac{(a + x)^{\rho-1}x - (a + x)^\rho/\rho}{x^2} < 0$$

since,

$$(a + x)^{\rho-1}x < (a + x)^\rho < (a + x)^\rho/\rho$$

In CARA case,

$$\frac{dV}{dx} = (1 - 1/\eta L) \frac{u'(x)x - u(x)}{x^2} = \frac{(ax + 1)e^{-ax} - 1}{x^2} < 0$$

In all the three cases, we find that the utility is decreasing in  $x$ . While,  $x$  is decreasing in  $\tau^c$ , which means an increase in  $\tau^c$  could lead to an increase in social utility. The implement of fiscal devaluation is able to help the market reach the social optimal welfare. And an increase of consumption tax can impulse the innovation, with the knowledge spillover improve the aggregate productivity and attract more firms entering the market. Producers are facing a more competitive environment and consumers with relative love of varieties have more choices at a lower competitive price. The welfare of consumers got improved.

## 5 Conclusion

Steaming from the fact that after the deficit crisis since 2012, fiscal devaluation has been recommended to many European countries as a solution and the implement practices in several countries, this paper summarizes some basic results from a theoretical view.

After introducing the concept of the relative love for varieties, I try to have a talk about the effect of the fiscal instrument on the real economy using the non-CES utility function (quadratic linear case, Stone-Geary case and CARA case). I find that the mark-up is equivalent to the relative love for variety which depends on the individual consumption.

Based on the results, I find that in the short run, the number of firms is fixed, the individual consumption is always decreasing in the consumption tax. In these models, markup is increasing in individual consumption, thus a decrease in consumption tax may lead to a lower markup, which is a pro-competitive case stimulating firms entering the market. In the long run, things become more uncertain. Choosing different utility function may lead to different outcomes where the steady state may not exist. Also the value of parameters can affect the final outcome. In generalized CES case, there is not steady state. While in the cases where the steady state exist (quadratic linear, Stone-Geary and CARA at proper parameter's values), the implement of fiscal devaluation leads to a lower individual consumption, lower mark-ups and higher number of firms, which is a pro-competition case. This again shows that the market structure and its reaction to the fiscal instruments may not only depends on the firms but also the characteristics of consumers (their utility function and relative love for variety). As to the price, it is affected by the consumption tax through two channels, which cannot be confirmed. In general, the implement of fiscal devaluation can help the economy reach social optimal status, where the market is more competitive and consumers have more choices.

To fully understand the effects and working mechanisms of the fiscal devaluation, opening the border of the economy is essential. This will be the next stage of my research about this topic.

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## A Appendix: Recent Examples

### 1. Germany

The VAT increase was announced in December 2005 and ratified by Parliament in mid 2007 by 3 percentage to finance the reduction of contributions to the unemployment insurance scheme. The tax increase (Keen and de Mooij, 2012) was to affect all items liable to the standard rate of 16 percent and items under the reduced rate such as basic food or books and entertainment are not affected Danninger and Carare (2008). Those fiscal policies in Germany since 2006 have been recognized as a successful reform and have made positive effects on German economy, while we need to realize that the improvement in employment also reflected the impact of several years of wage restraint that followed the labour market reforms of 2002-2005 (Puglisi, 2014).

### 2. Spain

The changes in the employment social security contribution (ESSC) implementing in Spain were targeted at the weakest groups on the labour market. In 2009, Spanish government introduced reductions for employers who hired unemployed workers with children. In March 2013, the national ‘Youth Employment and Entrepreneurship Strategy 2013-16’ contains subsidies for hiring young people in the form of reductions in or temporary exemptions from ESSCs. With regard to compensating fiscal revenue, the standard VAT rate increased by 2% in 2010 and 3% in 2013, and the reduced VAT rate increased from 7% to 10%.

### 3. France

In early 2012, France proposed ‘Social VAT’ which targets at lowering ESSCs and increasing the VAT rate from 19.6% to 21.2% (while not fully implemented yet). In 2013, the government approved a tax credit for competitiveness and employment (CICE). In 2014, the CICE was complemented by ‘Responsibility and Solidarity Pact’(RSP), which would reduce the tax burden of the employers. The whole package was worth 30 billion euros. Examples to compensate fiscal revenue include the standard VAT rate increasing from 19.6% to 20%, the reduced VAT rate on restaurant food and similar services increasing from 7% to 10%, etc.