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PRODUCTIVE PUBLIC SPENDING IN A BALASSA-SAMUELSON MODEL OF DUAL INFLATION

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PRODUCTIVE PUBLIC SPENDING IN A BALASSA-SAMUELSON MODEL OF DUAL INFLATION*

Abstract

Dual inflation takes place when price increases in non-tradable goods are higher than those of tradable goods. In this paper, we develop a model where public spending has a positive externality on the production of both sectors. The main results suggested by the paper are the following: 1) An increase in non-productive public spending does not generate dual inflation, as the usual Balassa-Samuelson result states and 2) An increase in productive public spending raises the productivity of both sectors and this can result in dual inflation, dual deflation or no effect on prices. Dual inflation only takes place when public spending has a bigger effect on the production technology of the tradable sector than on the non-tradable one.

KEYWORDS: Dual inflation, productive public spending, competitiveness.

JEL CLASSIFICATION: E3, E62, F41.

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1 Introduction

De Gregorio, Giovannini and Krueger (1994) show that for many European countries, prices of services sector, that does not face foreign competition, grow quickly when they are compared with industrial prices. Indeed, this fact is commonly known as dual inflation. We should highlight that dual inflation is a problem in some European countries because it can imply a competitiveness loss. The reason is simple: a rise in the price of services implies that their production is relatively more profitable. This entails that productive resources move out of the industrial sector and into the services one. Wyplosz and Laszlo (1995) and Froot and Kenneth (1994) show that dual inflation can be understood as a real exchange rate appreciation and this results in a competitiveness loss. Dual inflation is an interesting economic question; why is the price growth of the non-tradable sector (services sector) higher than that of the tradable sector (industrial sector)?. In this paper we will try to provide some keys to answer this question.

The main objective of this paper is to analyze the effects of public spending on the prices of non-tradable goods in a Balassa-Samuelson model of dual inflation (See Balassa (1964) and Samuelson (1964)). The standard Balassa-Samuelson result states that dual inflation is generated by differences in productivity growth between the tradable sector and the non-tradable one. Indeed, dual inflation takes place when productivity rises in tradable goods are higher than those of non-tradable goods. In principle, these differences in productivity growth are caused by a different development of production technology in the sectors. This is the reason why the Balassa-Samuelson model pays so little attention on public spending. Apparently, public spending seems to have no direct effect on production technologies.

Nevertheless, Aschauer (1989) shows that public spending, in particular, infrastructures have a positive impact on aggregate production and productivity. In fact, the mentioned paper is the first of a wide set of studies that analyze how different items of public spending influence the aggregate production. In particular, infrastructures, education and R&D may have a positive impact on production and productiveness. These results suggest that any dual inflation analysis should take into account public spending.

To introduce public spending in our model, we follow Barro (1990) where the production function includes private capital, labor and public spending as productive inputs. With this production function specification, an increase in public spending raises output and productivity. In our model, we have two sectors, the tradable and the non-tradable and three productive inputs. Naturally, public spending has a positive effect on the productivity of both sectors.

The main results suggest by the paper are following: 1) an increase in public spending always expands output of non-tradable sector, but it does not mean an automatic decrease in the production of tradable sector. 2) non-productive public spending does not result in dual inflation. This is the expected result in a Balassa-Samuelson model of dual inflation. 3) An increase in productive public spending can result in dual inflation, dual deflation or no effect on prices. We will show that an increase in productive public spending raises the aggregate productivity of the economy; but it leads to dual inflation when public spending has a bigger impact on production technology of the non-tradable sector than on the tradable one. In a sense, it could be shocking that an increase in aggregate productivity results in dual inflation that can be interpreted as a competitiveness loss.

We must accept that our paper has some limitations. In particular, this paper provides a "supply side explanation" for dual inflation. However, there is an extensive literature on dual inflation which gives "demand side explanations". For example, De Gregorio and Wolf (1994) and Alogoskoufis (1990) suggest that non-productive public spending increases result in dual inflation. Basically, the reason is that an increase in public spending expands the non-tradable demand and it leads to a rise in the prices of non-tradable goods. In the Australian model, dual inflation is generated by the differences in productivity, in demands, and in wages of both sectors. Finally, the Scandinavian model of dual inflation points out foreign inflation, exchange rates and productiveness as dual inflation origin. Frisch (1977), Kierzkowski (1976) and Lindbeck (1979) develop the latter model. All these models show that, even though differences in productiveness growth between the sectors can cause dual inflation, we must notice that there can be other reasons for dual inflation.

Finally, we estimate the effect of productive public spending on the price of non-tradables goods using a balanced panel data for 17 Spanish regions. We find that a rise in public spending in a region has a positive effect on aggregate productivity, but it results in a higher price of non-tradable goods and then in dual inflation.

To sum up, we conclude that public spending can generate dual inflation because it has a positive effect on productivity of both sectors. Nevertheless, our analysis does not take into account other causes that can generate dual inflation.

This paper is organized as follows: in section 2 we present the model. Section 3 studies the equilibrium. In section 4 we analyze the effects of fiscal policy on dual inflation. In section 5 we present some evidence for the Spanish economy. Section 6 summarizes our findings and draw conclusions.

2 The model

2.1 The basic framework

We develop a simple model of a small open economy with a fixed exchange rate and perfect mobility of private capital. There are two competitive sectors, the tradable and the non-tradable. The tradable sector faces foreign competition and the price of the tradable goods is internationally given. On the contrary, domestic market determines the price of non-tradable goods. The government finances public spending with a flat-rate production tax. For the sake of simplicity, the government only demands non-tradable goods.[1] Finally, both sectors use public spending as a productive input without any costs.

2.2 The firms

2.2.1 The tradable sector

There is a single competitive firm with a Cobb-Douglas technology with constant returns to scale in private capital and labor.

$$YT_t = AT_t \; LT_t^{\alpha} \; KT_t^{1-\alpha} \tag{1}$$

where YT_t is the output of the tradable sector, AT_t measures the technological development level of the tradable sector, KT_t is the private capital and LT_t is the labor. The technological parameter AT_t has the following structure:

$$AT_t = AT \; G_t^{\beta T} \tag{2}$$

[1] This assumption implies no restriction in the main results of the paper. For example, De Gregorio, Giovannini and Krueger (1994) use this simplification in their model.

where AT is a technological parameter and G_t is public spending. It is easy to see that public spending has a positive externality on the production only if $\beta T > 0$. The firm maximizes profits and labor and capital demands are:

$$LT_t = \alpha \frac{PT_t\, YT_t}{W_t} \tag{3}$$

$$KT_t = (1-\alpha) \frac{PT_t\, YT_t}{R_t} \tag{4}$$

where PT_t is the price of tradable goods and R_t is the price of private capital. Both prices are internationally given. Perfect capital mobility guarantees that the price of capital is exogenous. Finally, W_t is the nominal wage. The firm uses public spending without any costs.

2.2.2 The non-tradable sector

As in the tradable sector, there is a single competitive firm with a Cobb-Douglas technology with constant returns to scale in private inputs.

$$YN_t = AN_t\, LN_t^{\alpha}\, KN_t^{1-\alpha} \tag{5}$$

where YN_t is the output of the tradable sector, AN_t measures the technological development level of the non-tradable sector, KN_t is the private capital and LN_t is the labor of the non-tradable sector.[2] The technological parameter AN_t has the following structure:

$$AN_t = AN\, G_t^{\beta N} \tag{6}$$

where AN is a technological parameter and G_t is public spending. In this model, we assume that public spending is not subject to congestion effects. Public spending has a positive externality on the production of the

[2]We assume that the output elasticities of labor and capital are the same in both sectors. This could be taken as an important restriction of the model since it is commonly accepted that the elasticity of labor in the non-tradable sector is higher than the elasticity of labor in the tradable sector. However, in the Spanish economy, the share of wages in output -which approximates the value of elasticity of labor- is 0.62 in the non-tradables sector and 0.64 in the tradable sector. So this assumption is quite reasonable at least for countries like Spain.

non-tradable sector only if $\beta N > 0$. The firm maximizes profits and we can write labor and capital demands.

$$LN_t = \alpha \frac{PN_t \, YN_t}{W_t} \tag{7}$$

$$KN_t = (1-\alpha) \frac{PN_t \, YN_t}{R_t} \tag{8}$$

where PN_t is the price of tradable goods. The nominal wage W_t is the same in both sectors because there is a single labor market. As in the other sector, the firm uses public spending freely.

2.3 The government

The government finances public spending with a flat-rate production tax and runs a balanced budget. Government revenues are:

$$T_t = (PN_t \, YN_t + PT_t \, YN_t) \, \theta_t \tag{9}$$

where θ_t is the tax rate. We assume that the government only demands non-tradable goods.

$$G_{t+1} = \frac{T_t}{PN_t} = \frac{(PN_t \, YN_t + PT_t \, YN_t) \, \theta_t}{PN_t} \tag{10}$$

We assume government revenues become productive public spending one period later. A rise in θ_t leads to an instantaneous increase in tax revenues, but it increases productive public spending one period after. In other words, the government collects taxes and buys non-tradable goods in period t, and that spending ends up as usable capital for the firms in period t+1.

2.4 The demand

We assume that private demands are constant shares of the domestic aggregate production.[3]

$$CN_t = \frac{(1-s) \, \rho \, (PN_t \, YN_t + PT_t \, YN_t)(1-\theta_t)}{PN_t} \tag{11}$$

$$CT_t = \frac{(1-s)(1-\rho)(PN_t \, YN_t + PT_t \, YN_t)(1-\theta_t)}{PT_t} \tag{12}$$

[3] De Gregorio, Giovannini and Wolf (1994) find very similar private demands for a representative consumer that maximizes a Cobb-Douglas utility period-by-period.

where ρ is the share of private expenditure allocated in non-tradable goods and $(1-\rho)$ is the share allocated in tradable goods. The share of private income saved is s. Notice that an increase in the tax rate reduces net income and private demand. Nevertheless, the non-tradable demand includes private and public demand:

$$DN_t = \frac{T_t + CN_t}{PN_t} \tag{13}$$

In the model, a rise in public spending always expands the aggregate demand of the non-tradable goods DN_t. Finally, we use the real exchange rate as an index of competitiveness:

$$e_t = \frac{PT_t}{PN_t} \tag{14}$$

An increase in the real exchange rate means an improvement in competitiveness. The real exchange rate shows firm incentives that guide resource allocation across sectors; an increase in e implies that tradable goods production is now more profitable. This means that productive resources should move from the non-tradable sector to the tradable one (See Edwards (1989) for a more detailed explanation).[4]

[4] For example, Edwards (1989) says: "In most modern theoretical works "the" real exchange rate (e) is defined as the domestic relative price of tradable PT to non-tradable goods $PN : e = PT/PN$. This definition summarizes incentives that guide resource allocation across the tradable and non-tradable sectors; an increase in e will make the production of tradables relatively more profitable, inducing resources to move out of the non-tradables sector and into the tradables sector. In addition, this definition of the real exchange rate provides a good index of the degree of international competitiveness of the country's tradables sector. Indeed, this relative price measures the cost of producing domestically the tradable goods. A decline in the RER, or a real exchange rate appreciation, reflects the fact that there has been an increase in the domestic cost of producing tradable goods. If there are no changes in the relative prices of the rest of the world, this decline in RER represents a deterioration of the country's degree of international competitiveness[...]".

3 The equilibrium

3.1 Prices and nominal wage

We can obtain the price of non-tradable and tradable goods from expressions (3), (4), (7) and (8):

$$PT_t = \frac{\phi\ W_t^{\alpha}\ R_t^{1-\alpha}}{AT_t} \tag{15}$$

$$PN_t = \frac{\phi\ W_t^{\alpha}\ R_t^{1-\alpha}}{AN_t} \tag{16}$$

where $\phi = \alpha^{-\alpha}(1-\alpha)^{-(1-\alpha)}$.

The price of tradable goods is exogenously given because the power purchasing parity holds in the long run. It is easy to see that, in principle, PN_t decreases if there is a technological improvement in the non-tradable sector (AN_t increases). Using the above expressions, we can write the real exchange rate as follows:

$$e = \frac{PT_t}{PN_t} = \frac{AN_t}{AT_t} = \frac{AN\ G_t^{\beta N}}{AT\ G_t^{\beta T}} \tag{17}$$

The real exchange rate is determined only by technological conditions and it can be modified by the fiscal policy. This result is a generalization of the Balassa-Samuelson result. In this model, a rise in public spending can change the productivity of both sectors and, as a consequence, it can modify the relative prices of both sectors. An increase in public spending can cause three different effects on the price of non-tradable goods and on the real exchange rate:

1) if $\beta T > \beta N$, a rise in public spending increases the price of non-tradable goods. There is a real exchange rate appreciation.

2) if $\beta T < \beta N$, a rise in public spending decreases the price of non-tradable goods. There is a real exchange rate depreciation.

3) if $\beta T = \beta N$, a rise in public spending has no effect on the price.

Finally, if $\beta T = \beta N = 0$, public spending has no effect on output. In this particular case, an expansion of public spending does not change the relative prices and does not generate dual inflation. When public spending do not enter in the production function, the result obtained is the standard

Balassa-Samuelson result.[5]

>From (15) we can write the equilibrium nominal wage:

$$W_t = \left(\frac{AT_t \ PT_t}{R_t^{1-\alpha} \ \phi} \right)^{\frac{1}{\alpha}} \tag{18}$$

The tradable sector determines completely the equilibrium nominal wage in the model. A rise in AT_t increases nominal wage, i.e. a rise in public spending increases nominal wage if $\beta T > 0$.

3.2 Public spending

We substitute $PT_t \, YT_t$ and $PN_t \, YN_t$ by expressions (3) and (7) in expression (10) and we obtain:

$$G_{t+1} = \frac{(W_t \ LN_t + W_t \ LN_t) \ \theta_t}{\alpha \ PN_t} \tag{19}$$

We assume, for the sake of simplicity, that labor market is competitive. Without loss of generality, we impose $LT_t + LN_t = 1$. In the above expression, we substitute W_t and PN_t by expressions (17) and (18). This expression can be written as:

$$g_{t+1} = \ln \theta_t + \frac{\beta T - \alpha(\beta T - \beta N)}{\alpha} g_t + \frac{1-\alpha}{\alpha} pt_t + k_1 \tag{20}$$

$$k_1 = \frac{1-\alpha}{\alpha} (\ln AT + \ln R_t + \ln(1-\alpha)) + \ln AN \tag{21}$$

where g_t and pt_t denote the logarithm of public spending and price of tradable goods. k_1 is constant and exogenous. Expression (20) states public spending dynamics. In order to guarantee the existence of the steady state, we must impose the following restriction:

$$-1 < \frac{\beta T - \alpha(\beta T - \beta N)}{\alpha} = \frac{\beta T(1-\alpha) + \alpha \ \beta N}{\alpha} < 1 \tag{22}$$

This condition guarantees that public spending, that follows an AR(1) dynamics, is stationary. If $\beta T - \alpha(\beta T - \beta N) = \alpha$, the model would generate balanced endogenous growth.

Finally, from (20) it is straightforward that a rise in the tax rate at time t increases public spending at time t+1.

[5]In many other papers, non-productive public spending generates dual inflation . For example, Dixon (1994) and De Gregorio et al. (1994).

3.3 The steady state

To obtain the steady state of the model, we hold constant the tax rate ($\theta_t = \theta$) and the price of tradable goods ($PT_t = PT$). From expression (20), in the steady state, public spending is:

$$g = \frac{\alpha}{a}\ln\theta + \frac{1-\alpha}{a}pt + k_2 \tag{23}$$

where $a = \alpha - \beta T + \alpha\ (\beta T - \beta N) > 0$. We should notice that (22) guarantees $a > 0$.

An increase the tax rate or the price of tradable goods always raises public spending. This result contradicts Barro (1990) results for a close economy where productive public spending and the tax rate are linked with a Laffer curve. The reason for this difference is that in our model the interest rate is exogenous.

>From expression (23) we can obtain the following steady state variables: price of non-tradable goods, nominal wage, the real exchange rate, private capitals and outputs.

$$pn = \alpha\frac{\beta T - \beta N}{a}\ln\theta + \frac{\alpha - \beta N}{a}pt + k_3 \tag{24}$$

$$w = \frac{\beta T}{a}\ln\theta + \frac{1-\beta N}{a}pt + k_4 \tag{25}$$

$$e = -\frac{\alpha(\beta T - \beta N)}{a}\ln\theta - \frac{(1-\alpha)(\beta T - \beta N)}{a}pt + k_3 \tag{26}$$

$$yn = \frac{\beta T(1-\alpha) + \alpha\ \beta N}{a}\ln\theta + \frac{1-\alpha}{a}pt + \ln(\rho(1-s) + (1-\rho(1-s))\theta) + k_5 \tag{27}$$

$$yt = \frac{\beta T}{a}\ln\theta + \frac{(1-\alpha)(1-\beta N + \beta T)}{a}pt + \ln(1-\theta) + k_6 \tag{28}$$

$$kt = \frac{\beta T}{a}\ln\theta + \frac{1-\beta N}{a}pt + \ln(1-\theta) + k_7 \tag{29}$$

$$kn = \frac{\beta T}{a}\ln\theta + \frac{1-\beta N}{a}pt + \ln(\rho(1-s) + (1-\rho(1-s))\theta) + k_8 \tag{30}$$

where the small letters denote the logarithm of the variables and k_i is different constant for each expression.

The steady state conclusions settled in the next section rely on the following assumption: $\beta N < \alpha$. If this assumption does not hold, (24) states that pt increases decrease pn which is shocking. However, in this case, βN should be higher than 2/3 which is the share of income corresponding to labor for most countries and this is not likely.

4 Fiscal policy and dual inflation

In this section, we analyze the effect of a change in fiscal policy on endogenous variables when there is a permanent change in fiscal policy. We summarize the results for four different cases in Table 1.

[Insert Table 1]

4.1 Non-productive public spending $\beta T = \beta N = 0$

Public spending has no direct effects on production. Fox example, De Gregorio et al. (1994) and Dixon (1994) study this particular case in a different framework.

The relationship between θ and g is monotonic. A rise in the tax rate leads to an expansion in government revenues and public spending. However, that expansion of public spending has no effect on the price of non-tradable goods. The reasons for this are the following: 1) the non-tradable sector faces a competitive market and 2) the non-tradable production function has constant returns to scale in private inputs. These two facts imply that the marginal cost of production is the element that determines the price of non-tradable goods. An increase in public spending raises the demand of non-tradable goods, but does not vary their price. De Gregorio, Giovannini and Krueger (1993), Alogoskoufis (1990) and De Gregorio, Giovannini and Wolf (1994) show that this result does not hold when the non-tradable firm faces a monopolistic domestic market.

Public spending rises do not increase the productivity of the production factors, i.e. fiscal policy does not modify marginal costs of producing goods and, therefore it does not modify the price of non-tradable goods. In this case, public spending does not generate dual inflation, although it expands the demand of the non-tradable sector and, of course, enlarges its production.

Public outlays increases reduce the output of the tradable sector due to a decrease in the domestic demand that is caused by the rise in the tax rate. A rise in public spending moves out productive resources of the tradable sector into the non-tradable one, but it does not change marginal production costs.

Finally, the real exchange rate e holds constant.

4.2 Productive public spending with $\beta T = \beta N > 0$.

In this case, public spending has the same elasticity of production in both sectors.

An increase in g raises productivity of labor and capital in both sectors. In principle, this increase in productivity could lead to a decrease of both prices pn and pt. However, pt is internationally given. This means that an increase in productivity enlarges labor demand of the tradable sector which increases the nominal wage of the economy (w). On the contrary, the non-tradable sector can reduce its prices because it is domestically determined. Nevertheless, the increase in w -originated in the tradable sector- compensate completely the increase in productivity and it does not let a decrease in marginal production costs of non-tradable goods. The marginal costs of both sectors hold constant with the increase in g, even having g a positive externality in the productivity of both sectors. In short, the increase in w compensate completely the increase in productivity in the non-tradable sector and this keeps constant pn.

As in the previous case, there is a monotonic relationship between public spending and non-tradable production. A rise in g increases yn.

On the one hand, an increase in g raises the productivity of the tradable sector which should enlarge its production. On the other hand, a rise in θ reduces private net income and tradables domestic demand. As a result of these facts, we can distinguish two situations:

1) a rise in θ increases yt. This is the case if $0 < \theta < \beta T/\alpha$. In this situation the positive relation between public spending rises and productivity increases is stronger than the negative relation between the tax rate and the domestic demand of tradable goods.

2) A rise in θ reduces yt. This is the case if $\beta T < \theta < 1$. The argument is the opposite of the previous one.

In short, higher productivity, due to an increase in productive public spending, results in higher nominal wages that hold marginal costs of non-tradable sector constant. This means that the price of non-tradable goods and the real exchange rate keep constant too.

In a Balassa-Samuelson model only a different productivity growth in both sectors causes dual inflation. If $\beta T = \beta N$ a rise in public spending increases the aggregate productivity; but both sectors have the same productivity growth.

4.3 Productive public spending with $\beta T > \beta N$

Now, we assume that public spending has higher elasticity of production in the tradable sector than in the non-tradable one.

The main difference between this case and the last one is that a rise in g increases pn, i.e. a rise in g results in dual inflation (e decreases). The reason is simple: an increase in g raises the productivity of labor of the tradable sector which leads to a higher w, due to the exogeneity of the price of tradable goods. However, the increase in productivity of the non-tradable sector is not big enough to compensate the higher w which results in higher marginal costs. The non-tradable firm transfers these higher marginal costs to prices, because the non-tradable sector does not face foreign competition.

As in the previous case, the relation between g and yt is not clear. We can distinguish two situations:

1) A rise in θ increases yt. This is the case if $0 < \theta < \frac{\beta T}{\alpha(1+\beta T-\beta N)}$. On the one hand, an increase in g raises productivity. On the other hand, the rise in θ, needed to finance the increase in g, reduces private net income and the domestic demand of tradable goods. In this situation the first relationship is stronger than the latter one.

2) A rise in θ reduce yt. This is the case if $\frac{\beta T}{\alpha(1+\beta T-\beta N)} < \theta < 1$.

An expansionary fiscal policy leads to a competitiveness loss (a decrease in e). When $\beta T > \beta N$ the increase in w exceeds the increase in productivity of the non-tradable sector and, as consequence, marginal costs and prices of this sector go up.

In this case, a expansionary fiscal policy with a positive impact on productivity results in dual inflation and in a competitiveness loss.

4.4 Productive public spending with $\beta T < \beta N$

Public spending has higher elasticity of production in the non-tradable sector than in the tradable one. In this case, an increase in public outlays brings dual deflation on.

An expansionary fiscal policy increases productivity and nominal wages. However the increase in w is lower than the increase in productivity of the non-tradable sector and this decreases its marginal production costs. In this situation, the non-tradable sector can reduce the price.

It is important to highlight that a rise in g generates dual deflation and there is a competitiveness gain (e increases).

A rise in g has the same effect on yt than in the previous case.

4.5 The dynamics of the model

In this section, we specify the model dynamics. In particular, we study the dynamics of pn, g, e, yt and yn when there is a permanent change in θ. We start the analysis from a steady state situation with a constant tax rate θ_0. The government increases permanently the tax rate up to θ_1. Table 2 shows the growth rate of the mentioned variables.

[Insert Table 2]

At the first moment (t=0), an expansionary fiscal policy (from θ_0 to θ_1) has clear effects on the variables. Public spending holds constant, though tax revenues increases, because productive public spending is used by the firms in the next period (t=1). We should highlight that, at the first moment, there is no dual inflation and no competitiveness loss. As a consequence of this, pn does not change at time t=0. However, the increase in g expands non-tradable demand ($\nu > 0$) and reduces tradable demand ($\varphi < 0$). All the effects directly related to non-productive public spending take place during the first period (t=0).

The effects related to productive public spending take place after the first period (t=1,2,3..). We can distinguish to cases:

1) Non-productive public spending ($\beta T = \beta N = 0$). An increase in θ raises g, but the rest of variables keep constant. In particular, pn, yt and yn do not grow. It is easy to see, that $\psi = 0$, and then there are no dynamic effects in this economy.

2) Productive public spending ($\beta T > 0$, $\beta N > 0$). An increase in g has a positive impact on all the variables ($\psi > 0$). The positive effect is generated by the increase in productivity due to the rise in g. That positive effect decreases over time and become zero when the economy reaches the new steady state.

If η is big enough, the production growth of non-tradables exceeds the initial reduction of the domestic demand and the new steady state output is bigger than the initial one. On the contrary, if η is too small, the production growth of tradables goods does not neutralize the initial decrease in demand and the new steady output is smaller than the old one.

The effect on pn or e is not clear: if $\beta T > \beta N$ then pn increases and e decreases which means dual inflation and a competitiveness loss. This result determines when a expansionary fiscal policy results in dual inflation. On the contrary, if $\beta T < \beta N$ then pn decreases and e raises which means dual deflation and a competitiveness gain.

5 Evidence for the Spanish Economy

In this section, we evaluate the effect of productive public spending on the price of non-tradable goods. We use regional Spanish data for the following reasons: all the Spanish regions share the same currency and, of course, the same monetary policy. This implies that differences in princes among regions are generated exclusively by differences in non-tradables prices. On the other hand, we can assume that production function of both sectors are the same in all the regions. In particular, we assume that $\beta T - \beta N$ is the same in all regions.

>From a theoretical view, the idea is quite simple: we must estimate expression (17) to evaluate $\beta T - \beta N$. However, from an empirical perspective, we find some relevant problems. On the one hand, government public spending includes very different expenditure items, such as purchase of goods and services, compensation of employees, interest payments, gross capital formation, etc. Some of these items may have a positive impact on production, but others do not. In this section, we use stock of public infrastructure as a proxy of productive public spending.[6] In addition, we must distinguish between tradable and non-tradable goods to evaluate the ratio of both prices. However it is not always clear when a particular class or variety of goods is tradable or is not. To solve this problem, we assume the industrial price index as the price of tradable goods and we assume, for the sake of simplicity, that non-industrial goods are non-tradable goods.

We estimate the following expression using a balanced panel data of 17

[6]We exclude private infrastructures from the analysis.

Spanish regions, called Comunidades Autónomas, for the period 1978-1991.

$$\begin{aligned} pn_{it} - pt_{it} &= \ln \frac{AT_i}{AN_i} + (\beta T - \beta N) g_{it} + \varepsilon_{it} \\ i &= 1, 2, ...17, \ t = 1978, ..1991 \end{aligned} \tag{31}$$

The industrial price index is the same for all the regions, i.e. $pt_{it} = pt_{ij} = pt_t$. the price of non-tradable goods of each region has been constructed in the following the way: industrial prices correspond to approximately 40% of the Spanish Consumer Price Index, so we assume that the industrial prices (the price of tradable goods) correspond to 40% of CPI of each region and the price of non-tradable goods correspond to 60% of CPI.[7] In other words, PN_{it} is:

$$PN_{it} = \left(\frac{CPI_{it}}{PT_t^{0.4}} \right)^{\frac{1}{0.6}} \tag{32}$$

Finally, G_{it} is the stock of public infrastructure in each region.[8]

We take first differences to control for unobserved heterogeneity among regions, i.e. we apply within-groups estimation.

Table 3 shows the results of two different regressions for expression (31) in first differences. In the first column we estimate a simple model with public infrastructures as the only regressor and column 2 shows the result of the model including time dummies to control for possible business cycle effects.

[Insert Table 3]

Both estimations suggest that exists a positive relation between public infrastructure and the price of non-tradable goods. A rise in public infrastructure increases the price of non-tradable goods, that is, results in dual inflation.

These results show that a rise in productive public spending (infrastructure) in a specific region has positive and negative effects. A rise in productive public spending leads to higher productiveness which is positive, but it results in higher prices and a lower competitiveness which is negative.

[7] The share of Food, beverages and tobacco and Services correspond each to 30% of the Spanish CPI.

[8] Data source: BBV Foundation

6 Conclusions

In this paper, we develop a Balassa-Samuelson model of dual inflation and we study the effects of including public spending in this framework. Some previous papers blame that public spending increases cause dual inflation and lead to a competitiveness loss. Many of those papers study the effects of fiscal policy in a model with a monopolistic non-tradable sector. In that framework, a rise in public spending expands the demand of non-tradable goods and this causes dual inflation. However, in a Balassa-Samuelson model, dual inflation is caused when the productivity growth of tradable sector is higher than that of non-tradable one. In principle, in non-productive public spending cannot generate dual inflation, because it does not change the aggregate productivity of the economy.

We develop a model in which public spending has a positive externality on production of both sectors in a competitive environment. In this context, we show that a rise in non-productive public spending does not generate dual inflation, though productive resources move out of the tradable sector and into the non-tradable one. In this particular case, the result is the standard Balassa-Samuelson one. However, a rise in productive public spending raises the aggregate productiveness of the economy and it can take a bigger effect on the productivity of one sector. Indeed, dual inflation only takes place when public spending has a higher elasticity of production in the tradable sector than in the non-tradable one. The reason is basically the following: a rise in productive public spending increases labor productivity of the tradable sector and expands the labor demand of this sector. This fact increases nominal wages of the economy. This increase in nominal wages raise the marginal costs of non-tradable sector because the increase in nominal wages is higher than the productivity growth of that sector. Finally, the non-tradable sector translates higher marginal costs to higher prices which result in dual inflation and in a competitiveness loss. On the contrary, if public spending has a higher elasticity of production in the non-tradable sector than in the tradable one, the marginal costs of the non-tradable sector decrease which lead to a decrease in the price. Naturally, there is dual deflation and a competitiveness gain.

The model results suggest that one of the sources of dual inflation are differences in productivity growth between the two sectors which may have their origin in productive public spending rises. Nevertheless, non-productive public spending increases only move resources between the sectors, but have no effect on prices.

Finally, the analysis for the Spanish regions suggests that a rise in productive public spending results in dual inflation and in a competitiveness loss, though it increases productivity of tradable and non-tradable sector.

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8 Tables

Table 1

Sign of the partial derivative with respect to θ

	G	PN	W	YN	YT	KN	KT	e
$\beta T = \beta N = 0$	+	0	0	+	−	+	−	0
$\beta T = \beta N > 0$	+	0	+	+	?	+	?	0
$\beta T > \beta N$	+	+	+	+	?	+	?	−
$\beta T < \beta N$	+	−	+	+	?	+	?	+

Table 2

Growth rates of the endogenous variables when the tax rate goes up from θ_0 to θ_1

	t=0	t=1,2,3,..
G_t	0	$\psi^{t-1}\eta$
e_t	0	$-(\beta T - \beta N)\psi^{t-1}\eta$
PN_t	0	$(\beta T - \beta N)\psi^{t-1}\eta$
YN_t	ν	$\psi^t\eta$
YT_t	φ	$\psi^t\eta$

where ψ, η, ν and φ are:

$$\psi = \frac{\beta T(1-\alpha) + \alpha\,\beta N}{\alpha} < 1 \tag{33}$$

$$\eta = \ln\theta_1 - \ln\theta_0 > 0 \tag{34}$$

$$\begin{aligned}\nu = {} & \ln(\rho(1-s) + (1-\rho(1-s))\theta_1) - \\ & \ln(\rho(1-s) + (1-\rho(1-s))\theta_0) < 0\end{aligned} \tag{35}$$

$$\varphi = \ln(1-\theta_1) - \ln(1-\theta_0) < 0 \tag{36}$$

Table 3

Heteroscedasticity-consistent estimates in first differences of:

$$pn_{it} - pt_{it} = \ln \frac{AT_i}{AN_i} + (\beta T - \beta N) g_{it} + \varepsilon_{it}$$

	(1) Without time dummies	(2) With time dummies
G_{it}	0.10	0.09
	(0.03)	(0.05)

9 Supplementary explanations about the steady state equilibrium

In order to obtain the steady state equilibrium, we keep constant $\theta_t = \theta$, $PT_t = PT$ and $R_t = R$.

We substitute W and PN in (19) and we obtain the following expression for public spending:

$$G = \left(\frac{\theta (AT\ PT)^{\frac{1-\alpha}{\alpha}} AN(1-\alpha)^{\frac{1-\alpha}{\alpha}}}{R^{\frac{1-\alpha}{\alpha}}} \right)^{\frac{\alpha}{a}} \tag{37}$$

$$a = \alpha - \beta T + \alpha(\beta T - \beta N) \tag{38}$$

We can write the G taking logarithms:

$$g = \frac{\alpha}{a} \ln \theta + \frac{1-\alpha}{a} pt + k_2 \tag{39}$$

$$k_2 = \frac{1-\alpha}{a} \ln(AT + \ln(1-\alpha) - \ln R) + \frac{\alpha}{a} \ln AN \tag{40}$$

In order to obtain the steady state nominal wage, we substitute in (18) G by its expression and then we take logarithms.

$$w = \frac{\beta T}{a} \ln \theta + \frac{1 - \beta N}{a} pt + k_4 \tag{41}$$

$$k_4 = \frac{1-\beta N}{a} (\ln AT + \ln(1-\alpha) - \ln R) + \ln \alpha \tag{42}$$

If we use g and w, we can write PN as follows:

$$pn = \frac{\alpha(\beta T - \beta N)}{a} \ln \theta + \frac{\alpha - \beta N}{a} pt + k_3 \tag{43}$$

$$\begin{aligned} k_3 &= \frac{(1-\alpha)(\beta T - \beta N)}{a} (\ln(1-\alpha) - \ln R) \\ &\quad + \frac{\alpha - \beta N}{a} (\ln AT - \ln AN) \end{aligned} \tag{44}$$

On the other hand, government revenues are

$$
\begin{aligned}
T &= (PT\ YT + PN\ YN)\theta = \\
&= (W(LT + LN) + R(KT + KN)\theta
\end{aligned} \tag{45}
$$

We assume that $LT + LN = 1$. We substitute KT and KN by expressions (4) and (8).

$$
(PT\ YT + PN\ YN)\theta = \frac{W\ \theta}{\alpha} \tag{46}
$$

$>$From (11) and (12) and using the above expression, we can write the following expression for private demand of non-tradable goods:

$$
CN\ PN = \frac{W\ \rho(1-s)(1-\theta)}{\alpha} \tag{47}
$$

The aggregate demand of non-tradable goods is $CN + G$. If we take logarithms, we obtain:

$$
yn = \ln(\rho(1-s)(1-\rho(1-s)\theta)) + w - \ln\alpha - pn \tag{48}
$$

If we substitute pn and w by their expressions, we can write yn in the following way:

$$
\begin{aligned}
yn &= \frac{\beta T(1-\alpha) + \alpha\beta N}{a}\ln\theta + \frac{1-\alpha}{a}pt + \\
&\quad + \ln(\rho(1-s) + (1-\rho(1-s))\theta) + k_5
\end{aligned} \tag{49}
$$

$$
\begin{aligned}
k_5 &= \frac{(1-\beta T) + \alpha(\beta T - \beta N)}{a}(\ln(1-\alpha) - \ln R) \\
&\quad + \frac{1-\alpha}{a}\ln AT - \frac{\beta T - \alpha}{a}\ln AN + \ln\alpha
\end{aligned} \tag{50}
$$

In order to get the output of the tradable sector, we use expression (44):

$$
yt = \ln((1-\rho(1-s))(1-\theta)) + w - \ln\alpha - pt \tag{51}
$$

Again, if we substitute w by its expression, we can write yt in the following way:

$$
\begin{aligned}
yt &= \frac{\beta T}{a}\ln\theta + \frac{(1-\alpha)(1-\beta N+\beta T)}{a}pt + \\
&+ \ln(1-\theta) + k_5 \qquad (52)
\end{aligned}
$$

$$
\begin{aligned}
k_6 &= \frac{(1-\beta N)}{a}(\ln(1-\alpha) - \ln R + \ln AT) \\
&+ \ln(1-\rho(1-s)) \qquad (53)
\end{aligned}
$$

To obtain private capital of both sectors, we use first order conditions of the firms. It is easy to see that we can write both capitals as follows:

$$kt = \ln(1-\alpha) + pt + yt - \ln R \qquad (54)$$

$$kn = \ln(1-\alpha) + pn + yn - \ln R \qquad (55)$$

It is straightforward, that kt and kn can be written as:

$$kt = \frac{\beta T}{a}\ln\theta + \frac{1-\beta N}{a}pt + \ln(1-\theta) + k_7 \qquad (56)$$

$$
\begin{aligned}
k_7 &= (1 + \frac{1-\beta N}{a})(\ln(1-\alpha) - \ln R) + \frac{1-\beta N}{a}\ln AT) \qquad (57) \\
&+ \ln(1-\rho(1-s)) \qquad (58)
\end{aligned}
$$

$$
\begin{aligned}
kn &= \frac{\beta T}{a}\ln\theta + \frac{1-\beta N}{a}pt \\
&+ \ln(\rho(1-s) + (1-\rho(1-s))\theta) + k_8 \qquad (59)
\end{aligned}
$$

$$
\begin{aligned}
k_8 &= \frac{(1-\beta T-\beta N) + \alpha(1+\beta T-\beta N)}{a}(\ln(1-\alpha) - \ln R) \\
&+ \frac{1-\beta N}{a}\ln AT + \ln\alpha \qquad (60)
\end{aligned}
$$

Finally, we write the real exchange rate in the following way:

$$e = pt - pn = \frac{(1-\alpha)(\beta N-\beta T)}{a}pt - \frac{\alpha(\beta N-\beta T)}{a}\theta - k_3$$

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