Non-scale endogenous growth effects of subsidies for exporters[*]

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Abstract

We built a general equilibrium endogenous growth model in which final goods are produced either in the relatively skilled-labour intensive exports sector or in the relatively unskilled-labour intensive domestic sector. We show that, by affecting the technological-knowledge bias, subsidies explain the simultaneous rise in the exports sector, the skill wage premium and the economic growth rate. Then, to shed light upon the causal nexus between production-related subsidies and exports, we use a Portuguese longitudinal database (1996-2003) and implement a propensity score matching approach. Empirical results seem to prove the theoretical predictions: subsides generate the rise in the wage premium of exporters and the increase in the relative size of export sector, even if no impact of subsidies is found in the capacity of transforming domestic firms into new exporters.

Keywords: Subsidies; Exports; Scale-invariant growth; Wages.

JEL classification: C61, J31, O31, F13, F14, H29.

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1. Introduction and literature revision

Exports are crucial for the economic growth of most countries and it is well known that firms must overcome several difficulties and costs in order to be able to export. Some recent theoretical models (e.g., Melitz 2003; Chaney 2008) and some empirical studies (e.g., Wagner, 2007 and Wagner, 2011) found entry sunk costs of exporting as decisive. Meanwhile, several governments have designed several export promotion policies in order to deal with such costs and difficulties, even if direct export subsidization may be forbidden by World Trade Organization (WTO) rules.

Export subsidies, one of those policies, can be either specific (*lump sum*) or *ad valorem* payments to firms that ship goods abroad. Such subsidies can increase exports as they help supporting some of the exporting costs, induce more sales and create more earnings for exporters. However, such positive effects could become negative when the distribution of subsidies, instead of being a way to encourage trade orientation (by subsidizing those firms with comparative advantage) relies on subjective methods (based on arbitrary decisions) and becomes a rent-seeking mechanism. In this scenario, the competition among firms to obtain them may generate clear negative effects (e.g., Mitra, 2000) and the complexity of such decisions may open paths to misuse abuse (e.g., Nogués, 1989). Moreover, World Trade Organization (WTO) may even forbid such subsidies in certain circumstances.

Given such problems and the known difficulty in obtaining relevant data of export subsidies (from many public agencies), many researchers became to study, in alternative, the effects of general production-related subsidies on exports. Such type of subsidies may well play a relevant role in promoting exports (without violating WTO rules) and are easier

to collect[4]. In empirical terms, production subsidies[5], not specifically created to promote exports, are a type of financial assistance that firms receive from domestic authorities and the European Union, aimed at lowering their production costs and prices of the goods produced or even at providing a proper payment for productive factors. In accounting terms, they represent assistance, in the form transfer of resources, in return for past or future compliance under certain conditions related to firm's activities.

There is, however, little evidence that firm specific subsidies of all types (e.g., related to promote investment in technology, in training, in physical capital or in specific competences) can play a significant role in encouraging export activity (e.g., Gorg *et al*. 2008; Girma *et al*. 2009a, b). This lack of evidence may be caused by many reasons but too many different institutional arrangements (both formal and informal) designed to help reduce the sunk costs of exporting) could make it difficult to distinguish the mechanisms that are effective in promoting exports and those that are not.

The main motivation of this paper is to discuss the role of subsidies, especially production related subsidies, for exports; this analysis is done bearing in mind that there is a methodological difficulty in testing such relationship given that it is impossible to observe firms with and without such subsidies. Thus, in order to better evaluate which are the effects of (production) subsidies on exports, we present both a theoretical model and an empirical analysis. In both cases, we discuss the relationship between general production subsidies obtained by firms and several aspects related to their internationalization path,

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[4] They are freely available from firms´ accounts, not requiring a public agency source.

[5] Due to data limitations, we do not have means to distinguish between direct and indirect (R&D) subsidies, as we did in the theoretical model. Moreover, we have no information about the probability of such subsidies had been tailored for some sectors or for firms which have some specific characteristics.

such as their ability to promote R&D, to increase sales, to enhance market shares and also their capacity to pay higher wages.

From the theoretical perspective, international trade literature has given little attention to the role of endogenous technological knowledge (e.g., Rivera-Batiz and Romer 1991). We start this paper with a general equilibrium endogenous R&D growth model in which, in line with Rodrik (2006),[6] final goods are produced either in the relatively skilled intensive exports sector or in the relatively unskilled intensive domestic sector. Final goods use labour and quality-adjusted intermediate goods. Building on Acemoglu (2009, Ch. 15) scale-dependent horizontal R&D model, scale effects are removed (as proposed by the main related literature – e.g., Jones 1995) and vertical R&D is introduced (e.g., Acemoglu 2009, Ch. 14).

Given that many proposals to promote exports include R&D funding, in our theoretical model, due to the relationship between intermediate-goods production and R&D, R&D directed to improve "exporter" intermediate goods can be encouraged by either a direct subsidy or by a subsidy for the production of intermediate goods. As observed by Girma *et al*. (2009b), more than half of Chinese subsidies are allocated to innovation and technology promotion, which reveal that: (i) innovation activities are focused on high-tech firms; (ii) selected targets for subsidizing are based on firm features correlated with exporting.

In our (empirically plausible) context, in which there is complementarity between inputs and substitutability between sectors, numerical calculations describing dynamic equilibrium towards a stable and unique steady state show that subsidies under the price-channel mechanism affect the technological-knowledge bias. This bias, in turn, affects in a

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[6] This author use the China to show that, in each country, skilled labour is affected to the exporter sector.

positive way the exports sector, the growth rate (e.g., Acemoglu 2009, Part IV), the relative demand for relatively skilled labour and (thus) the skill-premium – in line with the developed and developing countries path, since the 1980s (e.g., Acemoglu 2009, Ch. 15).

After the theoretical analysis of the effects of subsidies to export producers, the paper provides a quantitative analysis to study the relationship between subsidies and exports in a large dataset of Portuguese firms for the period 1996-2003. By using propensity score matching procedures, this latter analysis takes into account the theoretical results and a few recent related empirical studies (e.g., Gorg et al. 2008, for Irish firms; Girma et al. 2009a, for German firms). In fact, in line with previous empirical studies, involving other countries, our empirical findings reveal that production subsidies have little impact on the likelihood that domestic firms will begin to export. Nevertheless, in line with the predictions of our theoretical model, empirical results also show evidence that production subsidies increase the wage premium of exporters and the relative dimension (size) of internationalized firms relative to domestic ones.

At another level, as production subsidies, in our database, are not specifically oriented to enhance exports but are devoted to promote employment, to support specific industries (eventually in some regions) and to help specific firms in difficulties, then we extend our analysis on the impact of such subsidies on general firm performances. We argue such analysis is of clear interest given that according to the European Union Treaty, any State aid to firms has in common the fact that they are granted by a member State or through State resources and that they favour certain undertakings or the production of certain goods. Nevertheless, they may also distort or threaten to distort competition, affecting trade between member States. Thus, new State interventions could be needed to reach a better allocation of resources but they may also harm the competition environment with negative consequences.

In this framework, the consequences of subsidies to firms could be either positive or negative and previous studies are not sufficiently clear: Bergström (1998) and Skuras *et al.* (2004) found that subsidized investments under regional development frameworks (structural fund programs) were ineffective. In this line, Gadd *et al.* (2009) present a summary on similar previous studies: (i) some positive effects on employment and on the dynamics of turnover and employment are reported for subsidized firms; (ii) negative effects on productivity growth rates are also observed in subsidized firms. Using a propensity score matching approach, the study of Gadd *et al.* (2009) for Swedish firms, concluded that subsidies enhanced employment growth levels of subsidized firms, but there was no positive effect on firms' productivity.

This paper is organised as follows. Section 2 presents the theoretical model framework; Section 3 derives the steady state and Section 4 analyses governmental intervention under the model. Section 5 describes the data used. Section 6 reveals some evidence on subsidies and exports in Portuguese firms. Section 7 shows econometric results. Section 8 extends the analysis of subsidy effects on other firms' general variables. Section 9 concludes the paper.

2. The theoretical model

2.1. Product and factor markets

Following Afonso (2006), each perfectly competitive final good $n \in [0, 1]$ is produced either by the Domestic or the Exports sector. In line with Rodrik (2006), the former (latter) uses unskilled (skilled) intensive labour, L (H), and a continuum set of intermediate goods, $j \in [0, J]$ ($j \in]J, 1]$). The output of n, Y_n, at time t is given by:[7]

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[7] Even if we consider that exports are mainly goods and non-exports are mainly services, the cut assumed is straightforward. Indeed, services like tourism are now an important export industry.

$$Y_n(t) = A \left\{ \left[\int_0^J \left(q^{k(j,t)} x_n(k,j,t) \right)^{1-\alpha} dj \right] \left[(1-n) \, l L_n \right]^\alpha + \left[\int_J^1 \left(q^{k(j,t)} x_n(k,j,t) \right)^{1-\alpha} dj \right] \left[n \, h \, H_n \right]^\alpha \right\} . \quad (1)$$

$A > 1$ is the exogenous productivity level. In the Schumpeterian tradition, integrals denote the aid of intermediate goods: each j quantity, x, is quality-adjusted; the quality upgrade is $q > 1$, and k is the top rung at t. The expressions with exponent $\alpha \in \,]0, 1[$ represent the role of labour inputs. An absolute productivity advantage of H over L is accounted for by $h \geq l = 1$. A relative productivity advantage of either labour type is captured by the terms n and $(1-n)$, which implies that H is relatively more productive in final goods indexed by larger ns, and *vice-versa*. The optimal choice for the sector at time t is reflected in the endogenous threshold final good $\bar{n}$, where the switch of production from L to H is advantageous. It follows from profit maximisation by producers of final goods, profit maximisation by monopolist firms of intermediate goods and full-employment equilibrium in factor markets, given labour supply and technological knowledge:

$$\bar{n}(t) = \left\{ 1 + \left[\frac{Q_H(t)}{Q_L(t)} \frac{h \, H}{L} \right]^{\frac{1}{2}} \right\}^{-1} , \text{ where:} \quad (2)$$

$$Q_L(t) \equiv \int_0^J q^{k(j,t)[(1-\alpha)/\alpha]} \, dj \text{ and } Q_H(t) \equiv \int_J^1 q^{k(j,t)[(1-\alpha)/\alpha]} \, dj \quad (3)$$

are aggregate quality indexes, evaluating the technological knowledge in each range of intermediate goods, and $D \equiv Q_H / Q_L$ is the technological-knowledge bias. $\bar{n}$ is small (the number of Exports final goods is large) when D is highly biased, H and/or h are large.

Defining the aggregate output, Y – resources for intermediate-goods production, X, R&D, R, or consume, C –,[8] as the numeraire,

$$Y(t) \equiv \int_0^1 p_n(t) Y_n(t) \, dn = \exp \left[\int_0^1 \ln Y_n(t) \, dn \right], \text{ since } \exp \int_0^1 \ln p_n(t) \, dn = 1, \quad (4)$$

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where $p_n(t)$ is the n price. $\bar{n}$ can be expressed in terms of L and H final-goods price indexes, p_L and p_H, since in $\bar{n}$ a L and H firm should break even,

$$\begin{cases} p_L = p_n (1-n)^\alpha = \exp(-\alpha)\,\bar{n}^{-\alpha} \\ p_H = p_n\, n^\alpha = \exp(-\alpha)\,(1-\bar{n})^{-\alpha} \end{cases} \text{ and thus } P(t) \equiv \frac{p_H(t)}{p_L(t)} = \left[\frac{\bar{n}(t)}{1-\bar{n}(t)} \right]^\alpha. \tag{5}$$

From (5), small $\bar{n}$ implies a small relative H final-goods price: the demand for each $j \in\,]J, 1]$ is low, which, as will be apparent below, affects R&D direction; thus, labour endowments, h and l influence the R&D direction through the price channel.

As Y is input of j and the government can pay an ad-valorem fraction, s_x, of each firm's cost, $(1-s_x)$ is the after-subsidy marginal cost. Intermediate good j embodies a costly R&D design recovered by protected (patent law) profits for a certain time in the future. Monopolistic profit-maximisation price yields $p = \frac{1-s_x}{1-\alpha}$, which, with $s_x < \alpha$, is a mark-up on 1, stable over t, across j and for all k. Since the leader is the only one legally allowed to produce top quality, it uses limit pricing $p = q(1-s_x)$ to capture the whole market.

Y and X (and R) are function of Q_L and Q_H. For example, Y is:

$$Y(t) \equiv \int_0^1 p_n(t)\, Y_n(t)\, dn = \exp(-1)\, A^{1/\alpha} \left[\frac{1-\alpha}{q(1-s_x)} \right]^{\frac{1-\alpha}{\alpha}} \left[\left(Q_L(t)\, L \right)^{\frac{1}{2}} + \left(Q_H(t)\, h\, H \right)^{\frac{1}{2}} \right]^2. \tag{6}$$

The price paid per labour unit, w_m ($m = L, H$), is equal to its marginal product. From (6), the skill-premium, W, is:

$$W(t) \equiv \frac{w_H(t)}{w_L(t)} = \left(D(t) \frac{h\, L}{H} \right)^{\frac{1}{2}}. \tag{7}$$

Thus, for example, an increase in h is a static benefit, see (6), which, due to the existing complementarity between inputs, falls $\bar{n}$, see (2), and increases W, see (7). Moreover, the stimulus to the demand for H, arising from the technological-knowledge bias, $D(t)$, increases the H-premium, which is in line with Choi and Jeong (2005).

2.2. R&D sector

R&D outcomes are designs to improve indexes in (3) – e.g., Acemoglu 2009, Ch. 14; in j at t, a firm engaged in R&D that uses $y(k, j, t)$ flow of Y upgrades the next quality, $k(j, t)+1$, with instantaneous probability:

$$pb(k, j, t) = y(k, j, t) \cdot \beta q^{k(j,t)} \cdot \zeta^{-1} q^{-\alpha^{-1}k(j,t)} \cdot m^{-1}, \text{ where:} \tag{8}$$

$m = L$ if $0 < j \le J$ and $m = H$ if $J < j \le 1$; $\beta q^{k(j,t)}$, $\beta > 0$, is the learning effect from past R&D; $\zeta^{-1} q^{-\alpha^{-1}k(j,t)}, \zeta > 0$, is the adverse effect of progressive complexity; m^{-1} is the adverse market-size effect.

The R&D incentive for follower firms relies on the expected monopoly profits flow, $V(k, j, t)$, which relies on its duration, on the interest rate, r, and on the profits at each t, $\Pi(k, j, t)$:[9]

$$\Pi(k, j, t) = \overline{m} \, m \, (1 - s_{x,m})^{\alpha^{-1}(\alpha-1)} \, (q-1) \left[\frac{p_m(t) \, A \, (1-\alpha)}{q} \right]^{\alpha-1} q^{k(j,t)\alpha^{-1}(1-\alpha)}, \text{ where} \tag{9}$$

$\overline{m} = h$ for $m = H$, $\overline{m} = l = 1$ for $m = L$, and s_x can be m-specific. The resulting V is:

$$V(k, j, t) = \frac{\Pi(k, j, t)}{r(t) + pb(k, j, t)}. \tag{10}$$

Under free-entry R&D equilibrium, expected returns are equal to the resources spent,

$$pb(k, j, t) \, V(k+1, j, t) = (1 - s_r) \, y(k, j, t), \text{ where:} \tag{11}$$

s_r is a governmental ad-valorem subsidy to R&D, which can be m-specific. Hence, due to the close relationship between intermediate-goods production and R&D, R&D directed to improve "exporter" intermediate goods is encouraged by either a direct subsidy, s_r, or by a subsidy for the production of intermediate goods, s_x. Equilibrium can be translated in the technological-knowledge path (Technology-curve):

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[9] Due to the Arrow effect, leaders do not undertake R&D (e.g., Acemoglu 2009, Ch. 14).

$$\hat{Q}_m(t) = \left\{ \underbrace{\frac{\beta}{\zeta}\left(\frac{1-s_{x,m}}{1-s_{r,m}}\right)\left(\frac{q-1}{q}\right)\left[\frac{p_m(t)\,A\,(1-\alpha)}{1-s_{x,m}}\right]^{\alpha^{-1}}\overline{m} - r(t)}_{\equiv pb_m} \right\}\left[q^{\alpha^{-1}(1-\alpha)} - 1\right]. \tag{12}$$

pb_m is the equilibrium m-specific pb, given r and p_m, which is independent from j and

k since the quality-rung effect in (9) and (8)-(ii) is offset by its effect in (8)-(iii). In line

with, e.g., Jones (1995), (8)-(iv) offsets the scale effect in (9); computing $pb_H - pb_L$, D is

thus particularly induced by subsidies under the price-channel mechanism.

2.3. Consumers

Fixed infinitely-lived households unelastically supply L or H, and choose a consumption

plan to maximize $U(t) = \int_0^\infty \left[\frac{C(t)^{1-\theta}-1}{1-\theta}\right] exp(-\rho t)\, dt$ subject to the standard no Ponzi games

condition and to the budget constraint $\dot{K}(t) = r(t)\,K(t) + w_m(t)\,m - C(t) - T(t)$, which yields the

consumption growth rate (Euler curve):

$$\hat{C}(t) = \frac{r(t)-\rho}{\theta}, \text{ where:} \tag{13}$$

$\rho > 0$ is the subjective discount rate; $\theta > 0$ is the relative risk aversion coefficient; K is the

total asset holdings, with return r, in the form of ownership of leaders (and not in public

debt owned by individuals, since, according to a simplifying assumption, the government

budget is always balanced); (ii) T is a lump-sum tax to finance subsidies.

3. Steady-state equilibrium

Q_L and Q_H must grow at the same rate since (i) Y has constant returns to scale in inputs, (ii)

Y, X, R and C are multiples of Q_L and Q_H, and (iii) in steady-state aggregates grow at the

same rate. From (12), $\hat{Q}_H = \hat{Q}_L$ if $\frac{p_H}{p_L} = \left(\frac{1-s_{x,H}}{1-s_{x,L}}\right)^{1-\alpha}\left(\frac{1-s_{r,H}}{1-s_{r,L}}\right)^{\alpha} h^{-\alpha}$; since r is unique, the steady-state

growth rate, g^*, is thus also unique. Also, from (2) and (5), $\frac{p_H}{p_L} = \left(D\frac{h\,H}{L}\right)^{-(\alpha/2)}$.

Consider, e.g., $pb_H > pb_L \Rightarrow \frac{p_H}{p_L} > \left(\frac{1-s_{x,H}}{1-s_{x,L}}\right)^{1-\alpha}\left(\frac{1-s_{r,H}}{1-s_{r,L}}\right)^{\alpha} h^{-\alpha}$. $pb_H > pb_L$ implies that $\hat{Q}_H > \hat{Q}_L$ and,

since $\frac{p_H}{p_L} = \left(D\frac{hH}{L}\right)^{-(\alpha/2)}$, $\hat{p}_H < \hat{p}_L$. Thus, $\frac{p_H}{p_L}$ falls towards $\frac{p_H}{p_L} = \left(\frac{1-s_{x,H}}{1-s_{x,L}}\right)^{1-\alpha}\left(\frac{1-s_{r,H}}{1-s_{r,L}}\right)^{\alpha} h^{-\alpha}$, which

attenuates the rate at which D is rising. Thus, while $\hat{Q}_H > \hat{Q}_L$, $\hat{Q}_H - \hat{Q}_L$ is falling until

achieving a stable g^*, where $\hat{Q}_H^* = \hat{Q}_L^*$, which, by (15), also implies a stable r^*:

$$g^* = \hat{Q}_H^* = \hat{Q}_N^* = \hat{Y}^* = \hat{X}^* = \hat{R}^* = \hat{C}^* = \frac{r^* - \rho}{\theta} \;\Rightarrow\; \hat{p}_H^* = \hat{p}_L^* = \hat{\bar{n}}^* = W^* = 0. \tag{14}$$

Hence, by $s_{x,m}$ and $s_{r,m}$, the government positively affects g^*, by encouraging R&D:

$s_{x,m}$ boost profits (9) and $s_{r,m}$ decreases the R&D cost, see (11)), which is consistent with

the findings in standard R&D endogenous growth models (e.g., Acemoglu, 2009), and with

convincing evidence found in works such as Bleaney et al. (2001).

4. Government intervention

As r is unique, (12) is used to analyse the effect upon $\bar{n}$ and W, of the D path given by

$$\hat{D}(t) = \frac{\beta}{\zeta}\left(\frac{q-1}{q}\right)\left(A(1-\alpha)\right)^{\frac{1}{\alpha}}\exp(-\alpha)$$
$$\left\{h\left(\frac{1-s_{x,H}}{1-s_{r,H}}\right)\left(\frac{1}{1-s_{x,H}}\right)^{\frac{1}{\alpha}}\left[1+\left(D(t)\frac{hH}{L}\right)^{-\frac{1}{2}}\right]^{\alpha} - \left(\frac{1-s_{x,L}}{1-s_{r,L}}\right)\left(\frac{1}{1-s_{x,L}}\right)^{\frac{1}{\alpha}}\left[1+\left(D(t)\frac{hH}{L}\right)^{\frac{1}{2}}\right]^{\alpha}\right\}, \tag{15}$$

using the 4th-order Runge-Kutta numerical method and the baseline values in Table 1.

< Table 1 should be considered here >

Figures 1a, 1b and 1c compare the baseline steady-state paths of D, $\bar{n}$ and W with

those arising from a change at $t=0$ where[10]: Sc1, $s_{x,H} = 0.2$; Sc2, $s_{r,H} = 0.2$; Sc3, $s_{x,H} = 0.2$

and $h = 1.55$; Sc4, $s_{r,H} = 0.2$ and $h = 1.55$. Thus, in Sc3 and Sc4, we consider that subsidies

also improve the absolute advantage of high-skilled labour; i.e., the advantage of labour

used in the exports sector. Table 2 shows initial and final steady states.

< Figure 1 should be considered here >

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[10] The effects induced by subsidies are in line with the findings in, for example, Cozzi and Impullitti (2010).

Subsidies accentuate D: Sc1, Sc3 and Sc4 increases the size of profits for the producers of $j \in]J, 1]$, and Sc2 and Sc4 decreases the cost of H-specific R&D. Towards the new steady state, such bias increases the supply of H-intermediate goods, thus raising the use of the exports sector, see (2), and lowering the relative P price, see (5). P drops continuously towards the steady-state, which implies that D is rising, but at a decreasing rate. D is thus motivated by the price channel, since there are stronger incentives to improve high-price goods. The effect upon D is stronger through direct R&D subsidy and without the level effect induced by h, due to the effect upon P.

< Table 2 should be considered here >

Competitiveness of the Exports sector is favoured in Sc2 and Sc4; in Sc2 mainly due to the path of D and in Sc4 owing to the level effect; the same happens for W, since in Sc2 and Sc4 the relative demand for H is strongly stimulated.

5. Data

Our data source is the Portuguese National Statistics Institute (INE) balance sheet information (IAE).[11] The IAE provides information on firms' balance sheets[12] and uses a survey sample of all Portuguese manufacturing firms with less than 100 employees and the universe of firms with 100 employees or more than 100 employees; our analysis has the time interval of 1996-2003. Firms are classified according to their main activity, as identified by INE's standard codes (CAE) that are correlated with Eurostat Nace 1.1 taxonomy. Despite being unbalanced, our database contains information for an average of

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[11] According to a Protocol established between the INE and the Faculty of Economics at the University of Porto, the authors have access to the data under specific rules of data confidentiality protection. Thus, without additional permission of the INE, data are available upon request only to confirm results.

[12] Since 2004, the INE has changed its methodology and works with all Portuguese manufacturing firms, but until 2004 the data used is the data available. The INE ensures the representativity of the sample used.

4,500 firms[13] per year. Our variables are: firms' employees, turnover, production subsidies, imports, exports, foreign capital, capital, labour costs, employees devoted to R&D activities and earnings. Tangible fixed assets at book value (net of depreciation) are used as proxy for capital. Nominal variables are measured in 1996 Euros and are deflated by using INE's 2-digit industry-level price indexes.

Moreover, since we needed a firm-level productivity measure and given that it is highly likely that profit-maximizing firms immediately adjust their input levels each time they observe productivity shocks, productivity and input choices are probably correlated and thus Total Factor Productivity (TFP) estimation involves problems. Thus, as done by several authors (e.g., Maggioni 2009), TFP is estimated by using the semi-parametric method of Levinsohn and Petrin (2003). This methodology recognizes the simultaneity bias as firms observe the productivity shocks, but econometricians do not. We compute TFP as the residual of a Cobb-Douglas production function[14] (for every 2-digit sector separately) in which the firm value added is the independent variable, and capital, labour and unobservable productivity level are the dependent ones. By using this methodology we assume that intermediate inputs present a monotonic positive relationship with productivity and thus could be used as proxies for TFP. In our specific case and given data availability, we use intermediate inputs consumed by firms as the deflated values of "supplies and services consumed by firms from third firms" at book value.

6. Evidences on exports and subsidies

Throughout the period 1996-2003, 26% of Portuguese firms received production-related subsidies at least for one year (Table 3); of the firms receiving subsidies, 80% were already exporters. The status of subsidized firms is highly stable: subsidy support was persistent as

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[13] We eliminated firms with a single employee.
[14] By using *levpet* command in Stata.

31% of all subsidized firms have obtained operating subsidies every year and more than half of the firms had subsidies for at least 6 years out of 8 (Table 4).

< Table 3 should be considered here >

< Table 4 should be considered here >

On average, for that period, subsidies represented 1.4% of sales, for subsidized firms, but there was time heterogeneity[15] (Table 5). Sector heterogeneity was also observed: food and beverage and furniture and recycling received the highest amounts of subsidies per sales and, in most cases, the highest amounts of subsidies per employee (Appendix A).

< Table 5 should be considered here >

For Portuguese firms, international trade (exports and imports) and production subsidies are much more concentrated than sales or employment, as measured by the Theil index for inequality assessment (Table 6).

< Table 6 should be considered here >

For the same period, we linked firm heterogeneity with trade status. In each year, all firms were classified into four mutually exclusive groups: Non-Traders (NT), Only Exporters (OE), Only Importers (OI) and Two-Way Traders (TWT). In our database about 74% of firms are engaged in external trade: the propensity to export (import) was, on average, 63% (69%). Between 1996 and 2003, the degree of Portuguese firm's engagement grew: in 1996, TWT represented 45% of firms and, in 2003, they corresponded to 53%. There is also clear evidence that the NT and TWT status are highly stable, while the OE and OI status are unstable (see Appendix B). However, the time persistency of our exporting firms was, on average, 3.8 over 8 years of our sample data-time lag. Moreover,

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[15] As an example from 2000 to 2001 there is a reduction of 50% in the average level of subsidy per employee,

18% of firms were exporters for every single year of the whole period, "persistent exporters", while 25% exported in only one single year.

Subsidies and exports are positively related (Table 7). In column 1 and line 1, we use as dependent variables a dummy for exporter status in each year and in column 1 and line 2, a variable for export shares in total sales; each of those variables are regressed upon a constant, a dummy for subsidized firms, sector codes and size. In column 2 similar regressions are performed, but firm fixed effects are added. We perform regressions using logit models for export status dummy and fractional logit models for export shares.[16] All regression coefficients are positive and statistically significant, even when controlling for firm fixed effects and sectoral and time effects.

Positive coefficients mean that subsidized firms are more probably exporters than non-subsidized firms (first line of regressions) and, among exporters, they present a higher share of exports relative to total sales (second line of regressions). The consistency of such coefficients is confirmed by the fact that, although not reported, such correlation is observable for each and every year between 1996 and 2003. However, those positive coefficients do not mean that there is a causal relationship between subsidies and exports.

< Table 7 should be considered here >

7. Evaluating the effects of production subsidies on exports

We divide the empirical section of the paper into two parts: in the first one, we study the impact of production subsidies on export probability and export intensity; in the second part, in order to establish better connections with the theoretical model, we analyse the effects of production subsidies on the wage premium of exporters, the R&D advantage of exporters and their market share.

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[16] We use fractional logit models since the share of exports in total sales is a percentage variable with a high probability at zero due to the large share of firms with no exports (e.g., Papke and Wooldrige 1996).

To study the causal effects of production-related subsidies upon the probability to start exporting (for non exporters) and upon export shares of total sales (for already exporters) we use a methodology, beyond simple regression analysis. Given that the positive relationship between subsidies and exports may be the result of both causality directions: (i) in line with the theoretical model through s_x and s_r, a production subsidy may help certain firms bear with the fixed costs related to the beginning of exporting or to deal with difficulties in some markers; moreover, production subsidies have the ability to reduce certain costs (labour or production costs) for existing exporters, thus inducing an increase in the share of exports in total sales; (ii) new exporting firms or firms exporting to some destinations may gain the right to collect production subsidies that governments use to "reward" such performances. Thus, the causality may run in both directions.

There are also other firms' features beyond production subsidies and exports that can affect both: Girma et al. (2009a) mention as an example the effect of R&D activities. It is also crucial to consider that production subsidies are not randomly given. They are instead allocated following a governmental conscious selection. In fact, we can consider two opposite selection methods: (i) one assumes that production subsidies are granted conditionally on the observation of certain criteria,[17] such as the export of certain goods, the types of workforce employed, the markets achieved by exports, the types of firms or sales from certain regions; (ii) the other selection method assumes that production subsidies are granted on the basis of firms' connectedness and proximity with the government or public officials and related members.

Despite being opposites, both introduce a selection criterion for subsidized firms, thus requiring methods (other than simple regression analysis) to properly evaluate the

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[17] The complexity of those criteria can create negative effects of subsidies upon firms' performances as some of them feel discouraged from applying for subsides (e.g., Helmers and Trofimenko 2009).

effects of production subsidies on firms' performance. By assuming that production subsidies (whatever form they take) are not randomly given, one cannot assess their effects simply by a simple comparison between subsidized and non-subsidized firms. This situation calls for the use of matching methods (e.g., Girma et al. 2009a). Indeed, the ideal method would be to compare, in a given year, the firm' performance (e.g., exports) under public subsidy with its performance without public subsidy (the counterfactual situation).

Since the information on the counterfactual situation will never be available, some authors (e.g., Heckman et al. 1998), argue that an adequate way to obtain an appropriate evaluation on the effects of the subsidies is to build a "control group" of firms that did not receive subsidies in that year, but which are as similar as possible to those firms receiving subsidies at that moment (the treated ones or starters).

By using matching techniques, we hope to build consistent counterfactuals to every firms subsidy "recipient", while using a generic non-subsidized firm the comparison group would not allow us to make causal inferences; in this case, the observed differences after subsidies could exist previously in a pre-subsidy period and remain after it. Thus, with this matching methodology we can match every treated firm with one or some control firms; to perform it, we use a propensity score computed from a probit of the treatment status on all relevant covariates (since the direct matching on these covariates is problematic when the set of variables is large, Rosenbaum and Rubin, 1984). Thus, we assume that future differences between treated firms and controls firms are the result of the treatment (subsidy) that one firm received and the other (control) did not.

As explained before, we are interested in two complementary approaches: (i) in line with our theoretical model, we intend to assess the impact of subsidies upon the probability that non-exporting firms will begin to export; (ii) additionally to assess the effects of subsidies upon the exporting performance of existing exporters.

To apply such a methodology, we consider for the first case, as the treated group for every year from 1998 to 2002, firms that in each year fill the following cumulative conditions: without subsidies in the two years before, one year before and in the year under consideration, and never exported until that year. For each year, the control group is formed by firms that verify both conditions: (i) had no subsidies in 1996-2002; (ii) did not export until the year under analysis. Appendix C presents the number of treated and control firms.

When studying the effects of subsidies on already exporters, we consider as the treated group of firms, for every year from 1998 to 2002, the firms that in each year fill the following cumulative conditions: without subsidies in the two years before, one year before and in the considered year, and with exports in the previous year. The control group is formed by the firms that both: (i) have no subsidies in the whole period 1996-2002; (ii) exported in the previous year. Appendix D shows the number of treated and control firms.

Operationally, we start by estimating the propensity score, which is performed by using a probit regression of a dummy variable equal to 1 if a firm is subsidized (treated) in that year and 0 otherwise. Such dummy is, as a base model, regressed on several variables lagged by one year (to respect the Conditional Independence Assumption). These variables are assumed to be relevant in the possible selection of firms to be subsidized[18]: number of employees, TFP, wages, a dummy for the existence of R&D workforce, a foreign capital dummy, earnings, sales and two digit sector dummies. Moreover, in the search for a higher quality match, different specifications were tested both for different years and for the pooled sample; nevertheless, given that the number of treated units is relatively small we argue that one pooled probit with year dummies would be more robust. In the next step of

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[18] By using general production subsidies, we consider as determinants for subsidy selection common variables mostly used in the previous empirical works (e.g., Girma et al. 2009; Gorg et al. 2008).

the matching procedure, we applied (to the pooled sample) two weighting schemes for propensity scores: kernel matching and nearest neighbour matching. Although both present similar results, given their smaller variance, we will present results based on the Epanechnikov kernel.[19]

In order to confirm the matching quality we implemented both a balancing test proposed by Becker and Ichino (2002) and a standard *T*-test for equality of means.[20] We also ensure the common support condition, which means that we drop subsidy starters,[21] which presented in each year a propensity score higher (lower) than the maximum (minimum) score for non-subsidized firms.

Since our purpose is to evaluate the effects of subsidies on the probability of a domestic firms to start exporting and on the share of exports of already exporting firms, we compute the average treatment effect on the treated (ATT) as follows:[22] (i) for the first case, we are interested in the differences between the percentage of export starters (the outcome variable) among subsidized firms (treated) and the same percentage for non treated firms; (ii) for the second case, ATT means the difference in the change of the share of exports in total sales (the outcome in question) between the treated firms (new subsidized in each year) and the same outcome for matched non treated firms (firms that remain non-subsidized in that year).

We assess ATT both for *t* and for the next three years: *t*+1, *t*+2 and *t*+3. When performing that second ATT we are controlling for unobservable, time-invariant

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[19] We use a bandwidth of 0.001. Results show little sensibility on the weighting regime used or within the bandwidth interval.

[20] The results (available upon request) show that after matching no differences were found in covariate means of treated and untreated firms; thus, after matching, we are not able to reject the null hypothesis of equality of means for all the relevant variables.

[21] Again, such results are available upon request.

[22] We use *psmatch2* command (version 3.0) for Stata 10.1.

differences between treated and non-treated firms; thus, we implement a difference-in-differences matching estimator (e.g., Blundell and Costa Dias 2000 and Heckman et al. 1998). Hence, we compare the changes in export performance after and before receiving the treatment (for the treated) with the same change recorded by control firms.

Results for the pooled sample of all years' causal effects of subsidies upon the propensity to start to export are reported in Table 8.

< Table 8 should be considered here >

In this empirical analysis the time span used is too short when compared with the period of transitional dynamics observed in section 4; such difference must be taken into account when comparing the two types of results obtained by subsidies. Empirically, we find no evidence of the effect of subsidies to enhance internationalization. Indeed, there is some evidence suggesting that subsidies could even imply a drop in firms' exports probability, mainly one year after the subsidy is received.[23] The poor effects of subsidies on the probability of generating new exporters may result from the fact that subsidies were improperly designed to specifically enhance exports. At the other level, results for the causal effects of subsidies on the share of exports in total sales of already exporters are reported in Table 9.

< Table 9 should be considered here >

There is no evidence that subsidies increase the share of exports in total sales, for the year subsidies start and for the next three years. In a complementary analysis and since subsidies present a relevant heterogeneity in values per employee, average levels by year (Table 5) and average levels by industry (Appendix A), it would be interesting to carry out an analysis on the effects of subsidies by also using a continuous treatment approach,

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[23] Although not reported, we have also tested similar effects for each of the single years of the sample, but no effects are observed.

varying between zero and a certain maximum level. However, the use of a generalized propensity score is hampered by the highly skewed subsidies' distribution per employee and even by the dominant share of non-subsidized firms.

Thus, to better study the impact of subsidy levels on the causality nexus (with the probability of exporting and with the share of exports in total sales), we repeated all previous tests but with more disaggregated data.

At one hand, we added an additional condition to treated firms – treated firms have to receive, in each year, a subsidy per employee higher than the double of each year's average subsidy per employee – to evaluate only highly subsidized firms and not all subsidized firms. This computation meant a reduction in treated firms by an average of 40%. The results of such causality effects of high subsidies upon the usual two dependent variables are expressed in Table 10; no significant effects were detected.

< Table 10 should be considered here >

At other hand, to take advantage of a sectoral analysis for the whole period 1998-2002, we performed a separate ATT for each of the available 23 two-digit industries. We must notice that the number of observations per sector did not allow us to carry out the analysis to all sectors.[24] However, we detected that the probability of domestic firms to become exporters was in fact increased for sectors related with the machinery cluster and involving all types of machines (electrical type, office type, motor vehicles and general machinery). Reversely, for the food and beverage sector, the subsidies even reduced the probability of domestic firms becoming exporters. For all other sectors, no evidence of any kind of effects was observed.

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[24] Given the small number of observations, we decided not to present the results in the form of table.

Regarding the change in export shares of already exporting firms, the available data allowed us to perform separate ATT computations for the majority of two digit industries. Results (in Appendix E) show that: (i) there are positive effects of subsidies upon export shares for basic metals, general machinery and electrical machinery; (ii) some sectors show negative effects of subsidies upon the share of exports in total sales (food and beverages, textiles, pulp and paper, fabricated metal products). However, given the dimension of our sample for most groups, extra precaution is needed regarding such general conclusions.

Complementarily, we have also performed two more tests: (i) firstly, we divided firms in two groups based on the initial TFP level; we observed, for firms with higher TFP levels, that subsidies generated a positive impact upon export shares, while for other firms there was no effect. Thus, we argue that subsidies have higher ability to cause positive effects upon exports when firms possess a superior absorptive ability (Table 11); (ii) in the second test, we assessed the effects of subsidies, conditional to the initial earnings level (Table 12), suggests that grants generate negative effects upon the probability for exporting of firms with positive earnings (in the first two years after subsidies are granted), while in firms with negative earnings no positive effects are detected.

< Table 11 should be considered here >

< Table 12 should be considered here >

8. Assessing the effects of subsidies on general firm performances

Using our database for Portuguese manufacturing firms, we performed other ATT computations to assess the effect of subsidies on other variables: wages, sales, R&D employment, employment, TFP and imports. Table 13 presents the effects of subsidies on domestic firms and Table 14 presents the same effects on already exporters.

The general conclusion is that subsidies generate more positive effects on firms already dedicated to exports and fewer effects on domestic firms. Such positive effects are

observed in exporters' employment, sales, efficiency (TFP) and R&D employment. For domestic firms, subsidies seem to "decrease" relative wages of newly subsidized firms, to increase firms' ability to import and also to improve firms's R&D ability.

When comparing domestic firms and firms dedicated to exports, we notice that subsidies seem to produce an increase in the wage premium in favour of exporters (as subsidies generate wage decreases in domestic firms but no significant effects in exporters), which is coherent with our theoretical result. Moreover, there is also an increase in exporters' sales relative to domestic firms, thus meaning that exporters increase their market share, which is again in accordance with the model's intuition. Moreover, for both group of firms, subsidies seem to reduce firms' earnings some years after subsidies are granted.[25]

We argue that, for domestic firms, some subsidies could be used to partially support the costs of some imported materials. Such effects are observed one year after subsidies have been granted. However, in spite of such positive effects, it does not produce any impact on those firms' exporting abilities.

< Table 13 should be considered here >

Overall, effects (positive and negative) seem to be more robust for domestic firms than for already exporters. Such superior strength of subsidies' effects also seems to perform more clearly in the year after subsidy reception than in the same year it occurs.

< Table 14 should be considered here >

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[25] Given data limitations we could not test this hypothesis any further. Anyway, we can argue that subsidies do harm firms' profits three years after having been received since the persistency of subsidies creates negative behaviors conducing to less efficiency in some firms.

9. Concluding remarks

The main purpose of this paper is to (both theoretically and empirically) discuss the effects of public policies for promoting exports. This discussion has not yet been made by the literature on international trade or by the widespread literature on wage inequality. Given this gap, we started by developing a dynamic general-equilibrium growth model with two sectors: the exports sector and the domestic sector. Growth is driven by Schumpeterian-R&D applied to quality-adjusted intermediate goods that complement labour. It is assumed that R&D directed towards the exports sector is encouraged by public policies, and we analyse the effects of a public intervention through an increase in public policies promoting R&D. Despite the complexity added to the production side of our economy, we reach a solution that delivers a unique and stable steady-state general equilibrium. We then carry out numerical analyses to solve the transitional dynamics towards the steady state. Government intervention, which promotes R&D in the exports sector, intensifies the technological-knowledge bias in favour of the exports side, which causes an increase in: (i) the competitiveness of the exports side; (ii) the wage premium in favour of exports workers; (iii) the economic growth rate. Consequently, at least temporary increases in taxes seem to arise as a valid argument to finance public policies promoting R&D.

In the next step of our paper we study, empirically, for the very first time for Portuguese firms, the links between production subsidies and exports. Although positively related, such link may suffer from endogeneity and sample selection problems. In order to deal with such handicap we apply a propensity score matching approach to uncover the real causal effects of subsidies on exports.

In line with most of the theoretical predictions, our empirical results found that subsidies increase the wage premium of firms already dedicated to exports and also increase the relative weight of exports, when compared with domestic sales. Moreover, we

also found a rise in the importance of R&D variable for both sectors, even if no increase in the technological- knowledge bias was empirically proved. Such fact could suggest the misuse of the distribution of production subsidies in Portuguese manufacturing firms.

At another level, our empirical results also showed that subsidies received by domestic firms had few impacts on their capacity to become new exporters; this could be the result from bad choices of public powers when distributing subsidies. Moreover, we also found that subsidies, granted to existing exports firms, show no significant effects on their exporting performances. Nevertheless, we have detected some evidence, for some specific sectors and cohorts, that production subsidies create some positive effects, namely for firms with superior efficiency levels.

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