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Political considerations and fiscal regulation in a spatial duopoly: Effects on product differentiation*

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Abstract

We examine the impact of political orientation on fiscal regulation and product differentiation within a spatial duopoly. Using a modelling approach a la Hotelling, we explore how the regulator's political stance -whether pro-consumer or pro-business- affects market outcomes through distinct optimal designs of fiscal intervention. We identify three regulatory profiles: (i) pro-consumer regulation with high tax rates leading to minimal product differentiation and lower prices; (ii) pro-business regulation with no taxation resulting in maximum product differentiation and higher prices, and (iii) moderate regulation, balancing the interests of firms and consumers, in which taxes can be moderate but the firms are not induced to follow the regulator's designated levels of differentiation. Our findings highlight the significant role of political orientation in shaping market dynamics and regulatory effectiveness, emphasising the need to consider political factors and the balancing of various actors in policy design within spatial competition models.

Keywords: *optimal fiscal policy, product differentiation, regulation and political affiliation in oligopolistic setting*

JEL classification: *L13, L50, R32, H21, C72*

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1. Introduction

The primary objective of this work is to investigate the influence of political orientation on fiscal regulation and its subsequent impact on product differentiation within an oligopolistic setting. We examine how the political positions of districts influence both policy design and market outcomes. Regulation is a defining feature of most, if not all markets; its form, motivation and objective can vary considerably. From improving upon a particular market failure to incorporating social, environmental or broader sustainability dimensions, political orientation is always present and determines, to a great extent, the shape and format of the regulation, as well as the final outcome. Political orientation may also manifest due to policy 'capture', lobbying of strong interest groups or simply political ideology driving the vision and design of government intervention.

Our paper focuses on the differentiation of products by firms within a spatial competition model. In particular, our analysis reconfigures equilibrium product differentiation of firms and explores how the degree of differentiation responds to fiscal regulation, itself influenced by distinct political stances. This is a noticeable novelty as, within the literature on product differentiation in oligopolistic settings, the main focus is either on market-drivers alone or on policy intervention of a 'social planner'. Political economy considerations are largely absent, despite their presence and relevance in real-life markets.[4]

Building on the seminal work of Hotelling and the vast literature that followed, we develop a duopoly model with horizontal product differentiation in which a politically charged regulator attempts to influence the market-based differentiation level through a combination of taxation and subsidisation schemes. The political orientation of the regulator is modelled through a welfare function that attaches different weights towards firms and consumers. In that sense, the resulting regulation scheme can be thought to be more pro-profits or more pro-consumers depending on the political stance or policy 'capture' of the regulator and is in line with works such as Hamoudi and Risueno (2012), White (2002) and Ghosh and Meagher (2015).

Our contribution focuses on understanding how political orientation influences the design of public interventions and the resulting outcomes, which are significantly affected by firms' responses. Specifically, our analysis identifies three categories of political profiles each associated with different regulatory strategies and distinct market results. Within the first range, the policymaker values consumers' interests more and this is reflected in a pro-consumer interventionist regulatory regime. Relying on the highest possible tax rate, the regulator proposes the centre as

[4] A notable exception is Ghosh and Meagher (2015), where in a different oligopolistic setting they investigate how the role of consumers as voters can influence transport infrastructure investment.

the ideal firms' location (differentiation). Fiscal policy is successful in inducing the firms to conform with its regulatory targets, and indeed firms locate at the market centre. The resulting differentiation is minimal, which intensifies competition and reduces prices to zero, benefiting consumers the maximum. In the second range, corresponding to the middle zone of political affiliation and more moderate regulatory profiles, the optimal tax rate is decreasing and differentiation increasing with respect to the relative weight attached to firms. In other words, firms' position is strengthened at the expense of consumers as political affiliation approaches more *liberal* positions. Within this range, two different subcases can be distinguished. First, if regulators are moderately inclined towards consumers, they prefer firms locating at the market centre. However, they do not succeed in inducing firms to follow, and the equilibrium result is moderate firms' differentiation. Second, regulators with a moderately free-market oriented profile choose reference locations at the extremes of the market. Again, they do not achieve this and the equilibrium result is also moderate; albeit the differentiation obtained is greater than in the previous case. Finally, regulators within the upper range of the political spectrum can be thought of as the most pro-business *liberal* ones. They apply a zero tax rate, while no preferred regulatory location is determined. Firms are not taxed and are let free to choose their location. The outcome is maximum differentiation and higher prices for consumers, coinciding with the market equilibrium in the absence of regulation.

In short, the key contribution of our work is that the regulation framework can be distinct due to the political stance of the corresponding policymaker and consequently the equilibrium of the system may no longer be the normative socially efficient. As present in the political economics literature that nonetheless has a macroeconomic focus, our microeconomic model attempts to delineate the policy design and market outcomes of, say, social democratic and more liberal political positions (and all spectrum therein). Drawing a parallelism from a general international comparison of different fiscal/welfare models, we see that they themselves reflect the broad political and ideological leanings of the countries involved. Countries with more interventionist social democratic models typically adopt systems with a higher tax burden, which also include subsidies and grants. Conversely, countries with more liberal ideologies tend to maintain greater market freedom and reduce the tax burden. In this context, Stenkula (2012) offers an international comparison of various welfare models and their tax systems, highlighting their impact on entrepreneurship. In the Scandinavian model with its social democratic traces (exemplified by countries such as Sweden and Denmark), firms face high levels of taxation, although social provision and in-kind transfers are also significant. In contrast, the Anglo-Saxon model, which has more liberal tendencies, features lower taxes that encourage entrepreneurship, though it offers fewer benefits and more targeted social transfers. Finally, the continental model (found in countries such as Germany and France) is situated among the two with intermediate levels of taxation and social provision and fiscal spending. In a very broad, if not simplistic, way our three identified political profiles capture these three realities. Quinn and Shapiro (1991) address how ideological differences between political parties in the US affect corporate taxation, reflecting the Democratic vs Republican contrast. While Democratic administrations tend to increase taxes on businesses and capital owners to promote consumption, Republicans prefer to reduce taxes on businesses to encourage investment. Janeba (2014) confirms what most of the political economics literature also predicts that left-wing politicians generally support higher tax rates on capital and business income, whereas right-wing politicians favour lower rates to stimulate investment.

2. Related literature

The seminal work of Hotelling (1929), initially intended to solve Bertrand's paradox Bertrand, 1883), incorporated the concept of firm location in a linear space and used distance across firms to formalise product differentiation. Based on linear transportation costs, Ho- telling showed that firms would agglomerate in the centre, later named the *principle of minimum differentiation*. d'Aspremont et al. (1979), using quadratic costs, refuted Hotelling's result, validating the principle of *maximum differentiation*. This stems from market power, leading firms to disperse in order to mitigate price competition, whereas *minimum differentiation* is driven by the market share effect; firms want to agglomerate, reduce prices and attract a bigger part of the market. Those two opposite principles have generated a long discussion and extensive literature on product differentiation. By altering particular assumptions of the original model, different equilibrium location configurations can be achieved. The most relevant modifications include: transportation costs, demand elasticity (e.g. Kitahara and Matsumura (2013), consumer heterogeneity (Tolotti and Yepez (2020)), distribution of consumer locations, uncertainty, different shapes and sizes of space (starting with the seminal work of Salop (1979)), number of firms, mixed duopolies (Cremer et al. (1991)), managerial delegation (see Bárcena-Ruiz et al. (2005), Kou and Zhou (2015), Matsumura and Matsushima (2012), Wang and Buccella (2020)). Regardless of the assumptions considered, in these models, firms always simultaneously confront the two opposite forces, power and market share, leading to a dilemma in location decision-making. In any case, depending on the approach, there may be a total or partial dominance of one of these effects such that, in the equilibrium, a minimum, maximum or intermediate differentiation is obtained. See Brenner (2001) and Biscaia and Mota (2013) for critical, although not exhaustive, reviews. Those two opposing effects are also present in our work and we demonstrate how the magnitude of each can be affected by the design of fiscal regulation, itself a product of political affiliation.

The aforementioned contributions all assume only market forces, ignoring the importance of regulation. Consequently, a part of the literature extends to incorporate a variety of regulation instruments, which can be grouped into three categories: i) fiscal, ii) zoning, and iii) environmental regulation. Lambertini (1997) relies on a taxation/ subsidisation fiscal regime to induce firms to select socially efficient locations, while Cremer and Thisse (1994), Kitahara and Matsumura (2013), Casado-Izaga (2010) and Colombo (2010) employ unitary, ad valorem and/or uniform commodity taxation and study their implications. Area zoning regulation and its impact on product differentiation is examined, amongst others, by Lai and Tsai (2004), Bárcena-Ruiz et al. (2014) and Cao and Wang (2022). Within the environmental regulation category, Conrad (2006) considers environmentally conscious consumers, while He and Deng (2020) bring to the fore the subjective and social effects of environmental awareness. Hamoudi and Aviles – Palacios (2022) consider both conscientious consumers and a regulator promoting a sustainable good. Lambertini (2013) provides a review.

The work most similar to ours is by Lambertini (1997), as both studies employ a fiscal scheme consisting of taxes and/or subsidies to encourage firms to choose the regulator's locations (or levels of differentiation) within a model of horizontal differentiation. However, we differ notably from Lambertini (1997) as we incorporate political considerations which determine the vision of the regulator and impact on the design of regulation and market outcomes obtained. Although political economy frameworks are common and flourishing in other areas of macroeconomic and microeconomic analysis alike (see for example Persson and Tabellini (2000)), they are not common within this line of microeconomic product differentiation research. To this end, our work is related to White (2002) and Hamid Hamoudi and Carmen Aviles-Palacios (2022) where either political objectives are present or a different vision of environmental sustainability is attached to the regulator. Either way the *social welfare function* is altered with important implications in the strategic interaction between the regulator and the firms and in market outcomes.

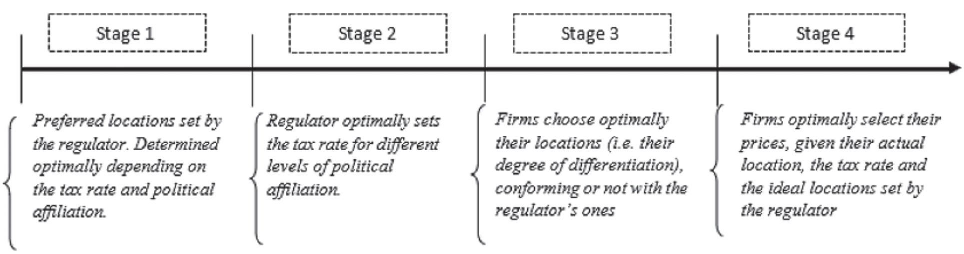
The remainder of the paper is structured as follows: Section 2 outlines the model; Section 3 determines the firms' optimal prices and locations and Section 4 examines the regulators' strategies and establishes three optimal tax rates associated with three political profile ranges. Section 5 presents the conclusion.

3. The Model

The basic framework of the model is the spatial private duopoly of d'Aspremont et al. (1979). The market is represented by a linear space where a continuum of consumers is uniformly distributed and where two firms produce a homogenous good, assuming zero production costs and no location restrictions (similar to Lambertini (1993) and Tabuchi and Thisse (1995)). As in Lambertini (1997), a fiscal regulator is introduced in the model, however, the fundamental difference from the latter lies on the political orientation of the policymaker. In line with White (2002), Hamoudi and Risueno (2012) or Hamoudi and Avilés-Palacios (2022) we move away from a *neutral* social planner to capture more realistic public stances in which regulators are driven by their political alignment and this is reflected on the regulatory schemes proposed. The regulator's strategic scheme consists of proposing certain reference locations and relying on a taxation/ subsidisation system to induce firms to select them. The particular regulatory scheme will depend on the political profile of the policymaker.

The model is formalised as a non-cooperative game in four stages. In the initial stage, the regulator sets its preferred locations. In the second one, the regulator decides its optimal tax rate for given levels of political affiliation, and, finally, in the last two successive stages the firms choose their locations and prices, respectively. As standard, the model is solved backwards.

Figure 1: Timeline of the model



Source: Authors' elaboration

3.1. Consumers, firms and the regulatory authority

Consumers are faced with a unit demand. Each consumer located at $x \in [0, 1]$ has a high enough individual income r to purchase the good and has no preference between the two firms when acquiring the product other than its price and transportation cost. The locations of the firms are denoted by x_i, $i = 1, 2 \in R$ with $x_1 \leq x_2$, and each good is sold at price p_i, $i = 1, 2$. The utility of consumer x when purchasing the good from firm located at x_i, is defined as:

$$u_i(x) = r - p_i - t(x - x_i)^2, \quad i = 1,2 \tag{1}$$

where r is their (exogenous) income and t denotes the disutility of consumers to the distance they need to cover in order to get the good in question, given by the quadratic term $(x - x_i)^2$.

The indifferent consumer $\tilde{x}$ is located at the point in which he/she is indifferent between the two goods and is determined through the equality $u1(\tilde{x}) = u2(\tilde{x})$, given by:

$$\tilde{x}\,(p_1, p_2) = -\frac{p_2 - p_1}{2t(x_2 - x_1)} + \frac{x_2 + x_1}{2}, \quad x_1 < x_2, \tag{2}$$

[5]

The demands for firms 1 and 2 are given by:

$$D_1(p_1, p_2) = \tilde{x}(p_1, p_2), \quad D_2(p_1, p_2) = 1 - \tilde{x}(p_1, p_2) \tag{3}$$

and since production costs are assumed to be zero, profits are equal to revenues

$$I_i(p_1, p_2) = p_i\, D_i(p_1, p_2)\,, \;\; i = 1,2 \tag{4}$$

At the pure market-based equilibrium, firms locate symmetrically at $x_1^* = -1/4$, $x_2^* = 5/4$. If firms are constrained to locate within the linear city [0,1], they will choose symmetrical locations, given by the opposite boundaries, $x_1^* = 0$, $x_2^* = 1$. In the absence of public intervention, the resulting *maximum differentiation* generates too much differentiation relative to the social optimum. Following Tirole (1990), by introducing a public administrator as manager of the two firms, that is, by setting up a public duopoly, one can achieve the socially efficient locations ($x_1^* = 1/4$, $x_2^* = 3/4$). In order to achieve the same socially optimum point, Lambertini (1997) introduces a fiscal regulator whose welfare function is represented by the linear combination of equally weighted consumer and producer surpluses. Lambertini adopts a taxation/subsidization scheme based on the firms' locations[6], with the following linear expression. We use the same specification in our model.

$$T_1(s_1, k) = A + k(s_1 - x_1), \quad T_2(s_2, k) = A + k\,(x_2 - s_2) \tag{5}$$

where s_1, $s_2 \in R$, with $s_1 \leq s_2$, represent the reference locations for the public authority. For model symmetry reasons and without loss of generality, it is assumed that $s_1 + s_2 = 1$. This implies that s_2 is rendered as a residual decision, in other words as soon as s_1 is optimally set, so is s_2. The tax rate, k, also a choice variable for the regulator, is considered non-negative and has a multiplicative effect on the deviation between the regulator's preferred locations and those chosen by the two firms. Parameter A is a real number that represents a lump-sum transfer and, depending on its value and sign, T_i can be a tax or a subsidy. The firms' profits are

$$B_i(p_1, p_2) = I_i(p_1, p_2) - T_i(x_i), \;\; i = 1,2 \tag{6}$$

[5] For $x_1 = x_2$ firms are located at the same point. The indifferent consumer cannot be determined. The solution of the problem is given by Bertrand's paradox.

[6] Since the market is completely covered at equilibrium, the price structure does not affect the standard welfare function.

The regulation proposed by Lambertini (1997) reflects the position of a fiscal regulator that is neutral with respect to the interests of consumers and firms, which also offers a normative definition of socially efficient locations. That is, firms' and consumers' surpluses are weighted equally. However, such neutrality does not always correspond to realistic situations. Policymakers establish regulatory mechanisms according to their political profiles and this is the main contribution of our model. We extend the model by considering a range of policymakers, with corresponding regulatory schemes, that represent more pro-business or pro-consumers political stances. In the same vein as White (2002) and others, the associated objective function is represented by a social welfare function in which a weighting factor is applied to the firms' and consumers' surpluses. In White's words, "while the standard, equally-weighted welfare function may be desirable for normative reasons, based on utilitarianism or fairness doctrines (as in Harsanyi, 1955), it may be restrictive for purposes of predicting the behaviour of actual public firms and the resulting market outcomes" (White, 2002, p. 489). Our extended welfare function is formulated as a linear combination of the surpluses of firms S_F, and, jointly, of consumers S_C and the public authority S_G. The regulator's political stance is quantified through the assignment of different weights to the interests of firms and consumers.

$$W = \lambda S_F + (1 - \lambda)(S_C + S_G), \tag{7}$$

where:

$$S_F = \sum_{i=1}^{2} B_i(p_1, p_2), \; S_C = R - \sum_{i=1}^{2} I_i(p_1, p_2) - C_T, \;\; S_G = \sum_{i=1}^{2} T_i(x_i)$$
$$C_T = \int_0^{\tilde{x}} c_1(x)\,dx + \int_{\tilde{x}}^{1} c_2(x)\,dx, \quad R = \int_0^1 r\,dx \tag{8}$$

R is total income for all consumers and C_T is total transport cost, given by the distance that each consumer has to cover to buy their selected product, and measured as the sum of distances to the left $(c_1(x))$ and right $(c_2(x))$ of the indifferent consumer.

The weighting parameter λ belongs to [0,1] and indicates the differentiated political stance and hence the degree of attention that the policymaker may grant to private duopoly profits as opposed to consumers' welfare. When λ = 1, the regulator has a pro-business orientation and exclusively favours the interests of firms. At the other extreme, when λ = 0, the regulator prioritises consumers solely. Intermediate values for λ capture the whole spectrum of political profiles, balancing the interests of firms and consumers, with higher values indicating a tilt towards pro-business regulation while a lower λ a tilt towards pro-consumer policies. Similar in spirit representations of welfare functions (with weighted preferences) are also to be found in the political economics literature (see for example, Pickering and Rockey (2011)). The principle is that party or policymaker's ideology is reflected in the design of policy intervention, and this has distinct final market outcomes.

Substituting the terms of the surpluses given by expressions in (8) in equation (7), the welfare function is given by

$$W = (2\lambda - 1)\,[B_1(p_1, p_2) + B_2(p_1, p_2)] + (1 - \lambda)[R - C_T] \tag{9}$$

By considering the regulator's political affiliation towards consumers and/or firms, the model includes all types of regulators and includes the work of Lambertini (1997) as a particular case. The following sections move to the backwards solving of the model.

4. Optimal firm strategies

At this stage of the game, firms compete on prices. Each firm maximises its profits with respect to its price, given the reference locations (s_1, s_2) and the tax rate k set by regulator with political stance λ, and to firms' locations (x_1, x_2). Considering profit functions given in (6), equilibrium prices are derived from the first-order condition of profit maximisation.

$$\begin{aligned} p_1^*(x_1, x_2) &= \frac{t}{3}(x_2 - x_1)\,(2 + x_2 + x_1), \\ p_2(x_1, x_2) &= \frac{t}{3}(x_2 - x_1)\,(4 - x_2 - x_1) \end{aligned} \tag{10}$$

Optimal prices, $p_1^*(x_1, x_2)$, $p_2^*(x_1, x_2)$, are not directly affected by fiscal regulation and neither is the demand. Substituting equilibrium prices $p_1^*(x_1, x_2)$ and $p_2^*(x_1, x_2)$ into the profit functions given in (6), we obtain

$$B_1\,(x_1, x_2) = \frac{t}{18}\,(x_2 - x_1)\,(2 + x_2 + x_1)^2 - A - k\,(s_1 - x_1) \tag{11}$$

$$B_2(x_1, x_2) = \frac{t}{18}\,(x_2 - x_1)(4 - x_2 - x_1)^2 - A - k\,(x_2 - s_2) \tag{12}$$

With regards to location and taking into account equations (11) and (12), equilibrium firms' locations do depend on the fiscal scheme selected by the regulation and this is analysed in proposition 1 below.

Proposition 1.

For any $t > 0$, $s_1 \in \left[-\frac{1}{4}, \frac{1}{2}\right]$ *and* $k \geq 0$, *there is one unique equilibrium location if and only if* $0 \leq k \leq t/2$, and $A \leq g(k)$. *The unique equilibrium is given by:*

$$x_1^*(k) = -\frac{1}{4} + \frac{3k}{2t}, \; x_2^*(k) = \frac{5}{4} - \frac{3k}{2t}.$$

Firms are being:

- *subsidized if* $A \in]-\infty, h(k, s_1)]$
- *taxed if* $A \in]h(k, s_1), g(k, s_1)]$

where

$$g(k, s_1) = \frac{1}{4t}[6k^2 - kt(4s_1 + 7) + 3t^2], \quad h(k, s_1) = \left(k/_{4t}\right)[6k - t(4s_1 + 1)]$$

Proof: See appendix

In other words, uniqueness of a location equilibrium is ensured when the tax rate stays within its lower range, $[0, t/2]$ and when A ensures profits are non-negative. At this game stage, no explicit relationship appears between firms' optimal locations and the regulator's political stance, as depicted by λ. This point will be further explored in the subsequent stages of the non-cooperative game. The choice between taxes or subsidies depends on the transfer A, as well as on the tax rate k and the preferred reference locations s_i. When the regulator is politically *neutral*, that is, it attaches the same weights to consumers' and firms' interests, \$λ = $1/2$, we obtain the following result, which matches Lambertini (1997).

Result 1. *(Due to Lambertini (1997)) If* $s_1, s_2 \in]-1/4, 5/4]$ *and* $s_1 + s_2 = 1$, *firms locate at the socially efficient positions if* $k = t/3$. For $A \in]t(1 - 4s_1)/12, t(1 - s_1)/3]$ *firms are being taxed, while they are being subsidised if* $A < t(1 - 4s_1)/12$.

This result is obtained by determining firms' optimal locations, and subsequently, deducting the tax rate that induces the firms to those socially optimal locations. In this scenario, the choice between taxes and subsidies depends only on transfer A and the regulator's reference locations s_i.

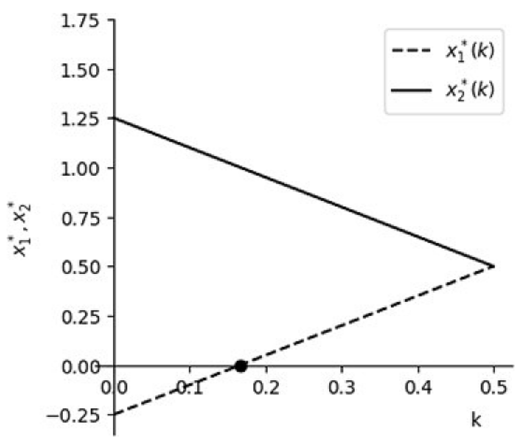
The introduction of a tax rate k in our model leads to a reduction in differentiation and prices. Product differentiation, defined as the distance in optimal locations across the two firms, is given by $Z(k)$ as a function k below.

$$Z(k) = (x_2^*(k) - x_1^*(k)) = \frac{3}{2t}(t - 2k) \tag{13}$$

$$p_1^* = p_2^* = \frac{3}{2}(t - 2k) \tag{14}$$

Within the range $\left[0, \frac{t}{2}\right]$ for the tax rate, firms choose the same location, $x_1^* = x_2^* = 1/2$, differentiation is minimal, price competition very intense, $p_1^* = p_2^* = 0$, and revenues zero. Assuming zero production costs, the profits are simply what results from the fiscal scheme, and the regulator will have to subsidise the firms. At the lowest limit, given by the null rate $(k = 0)$, each firm is located far away from its rival $(x_1^*, x_2^*) = (-1/4, 5/4)$ and competition is significantly softened $p_1^* = p_2^* = \left(\frac{3t}{2}\right)$. However, depending on the lump-sum transfer *A* the regulator's fiscal policy can be a tax or a subsidy. For values of k such that $0 < k < t/2$, one finds that as the rate k increases, product differentiation decreases, moving from maximum to minimum. Figure 2 illustrates the relationship between optimal locations (x_1^*, x_2^*) and the tax rate k for a numerical example in which $t = 1$.

Figure 2: Optimal firms' locations and the tax rate



Source: Authors' calculations

By substituting the equilibrium locations (x_1^*, x_2^*) respectively into equation (5) of the tax scheme and(11) and (12) of profits, we obtain

$$T_i^*(k, s_1) = \frac{1}{4t}[-6k^2 + kt(4s_1 + 1) + 4At] \tag{15}$$

$$B_i^*(k, s_1) = \frac{1}{4t}[6k^2 - kt(4s_1 + 7) + 3t^2] - A \tag{16}$$

As can be observed in equation (16), the regulator's fiscal instruments, s_1, k, may significantly affect firms' profits. Hence, the regulator will try to determine an optimal fiscal policy to induce firms to follow its guidelines. In the next section, we analyse optimal regulator strategies for different shades of political orientation, as represented by λ.

5. Optimal fiscal framework for different political profiles

The focus here is on the strategic interaction between the fiscal regulator with affiliation λ and the firms by sequentially determining the optimal regulatory instruments k^* and (s_1^*, s_2^*). Subsection 4.1 establishes the optimal tax rate k^* and subsection 4.2 identifies the reference locations, (s_1^*, s_2^*) as well as the impact on differentiation between firms.

5.1. Optimal Tax rate

Considering optimal firms' strategies (x_1^*, x_2^*) and assuming the reference location s_1 in $[{}^{-1}/_4, {}^{1}/_2]$ and $\lambda \in [0,1]$, we now determine the optimal tax rate k^*, by maximising the welfare function, defined in (7), W with respect to k in $[0, {}^{t}/_2]$. By substituting x_1^* and x_2^* in equation (7) and assuming $s_1 + s_2 = 1$, the welfare maximisation problem is

$$W = \frac{3}{4t}(11\lambda - 7)k^2 - \frac{1}{2}[4(2\lambda - 1)s_1 + (17\lambda - 10)]k - \\ - 2(2\lambda - 1)A + (1 - \lambda)R \tag{17}$$

Given the functional form of W and the constraint $k \in \left[0, \frac{t}{2}\right]$, solutions to maximisation problem (17) can be several: (i) corner solutions, corresponding to the extremes of the interval $\left[0, \frac{t}{2}\right]$, that is, $k_1^* = {}^{t}/_2$, $k_3^* = 0$, (ii) and interior solution(s), given by the first order condition and whose expression for $\lambda \neq {}^{7}/_{11}$ is:

$$k_2^* = k(s_1, \lambda) = \frac{t}{3(11\lambda - 7)}[4(2\lambda - 1)s_1 + (17\lambda - 10)] \tag{18}$$

The tax rates k_1^*, k_2^* and k_3^* will be possible solutions if the non-negativity of the profits is verified, i.e., $A \leq g(k_i^*)$, where:

$$g(k_1^*) = \frac{t}{2}(1 - 2s_1),\ g(k_3^*) = \frac{3t}{4} \tag{19}$$

$$g(k_2^*) = \frac{t}{12(11\lambda - 7)^2}\left(16\, b_1(\lambda)\, s_1^2 + 4\, b_2(\lambda) s_1 + b_3(\lambda)\right) \tag{20}$$

Expressions $b_1(\lambda)$, $b_2(\lambda)$ and $b_3(\lambda)$ are given by:

$b_1(\lambda) = -14\lambda^2 + 17\lambda - 5$, $b_2(\lambda) = -205\lambda^2 + 256\lambda - 79$, $b_3(\lambda) = 358\lambda^2 - 463\lambda + 151$.

The interior solution $k(s_1, \lambda)$ reaches the extreme values of the interval $\left[0, \frac{t}{2}\right]$, for any value of $\lambda \neq 1/2$, in the following cases:

$$k(s_1, \lambda) = 0 \ \ if \ \ s_{11}(\lambda) = \frac{17\lambda - 10}{4(1 - 2\lambda)} \tag{21}$$

$$k(s_1, \lambda) = \frac{t}{2} \ \ if \ \ s_{12}(\lambda) = \frac{1 + \lambda}{8(1 - 2\lambda)} \tag{22}$$

Depending on the variation of λ in its permitted interval [0,1] and of s_1 in the range $[-1/4, 1/2]$, one of the three rates k_1^*, k_2^* and k_3^*, might be the solution. In the following propositions we determine the different ranges of political affiliation for λ, corresponding to each of the above optimal tax rates.

Proposition 2. *For* λ *in* $\left[0, \frac{1}{3}\right]$ *such that* $s_{11}(\lambda) \leq -\frac{1}{4} \leq s_{12}(\lambda) \leq \frac{1}{2}$, *and a reference location* s_1 *in* $\left[s_{12}(\lambda), \frac{1}{2}\right]$, *the optimal tax rate is* $k_1^* = \frac{t}{2}$, *with* $A \leq g(k_1^*)$ *where* $g(k_1^*)$ *is given by (19).*

Prof. See appendix

This first interval $\left[0, \frac{1}{3}\right]$ for λ comprises of regulators that attach a higher weight on consumer's interests. The regulatory profile corresponds to the most interventionist position and the rate k_1^* is the highest, a result consistent with a pro-consumer political stance. Firms' optimal location strategy is to agglomerate at the market centre, $x_1^* = x_2^* = 1/2$. Therefore, differentiation is minimal $Z(k_1^*) = 0$, and prices are nil, benefiting consumers to the maximum. By substituting k_1^* into the welfare function W, we obtain a new welfare expression that depends on the reference location, s_1

$$W(s_1, \lambda) = -t(2\lambda - 1)s_1 + \frac{5t}{16}(2 - 7\lambda) - 2(2\lambda - 1)A + (1 - \lambda)R \tag{23}$$

In this scenario, the optimal reference locations are given by $s_1^* = s_2^* = 1/2$. Nonetheless, this policy choice does not affect the firms' optimal location strategies, which are only directly influenced by the tax rate. This result leads to losses if it is not compensated by a subsidy through the lump-sum transfer A.

Proposition 3. *For* λ *in* $\left[\frac{1}{3},\frac{1}{2}\right[\cup \left]\frac{1}{2},\frac{3}{5}\right]$ *such that* $min\{s_{11}(\lambda), s_{12}(\lambda)\} \leq -\frac{1}{4} \leq max\left\{s_{11}(\lambda), s_{12}(\lambda), \frac{1}{2}\right\}$*, and a reference location* s_1 *in* $\left[-\frac{1}{4}, ax\left\{s_{11}m(\lambda), s_{12}(\lambda), \frac{1}{2}\right\}\right]$*, the optimal tax rate is* $k_2^* = k(s_1, \lambda)$ *with* $A \leq g(k_2^*)$ *where* $g(k_2^*)$ *is given by (20).*

Proof. See appendix

In the middle range of the regulatory political spectrum, the optimal rate k_2^*, as well as firms' differentiation and, therefore, price competition, are moderate. In other words, when the weights on consumers and firms are somewhat similar, the equilibrium result corresponds to moderate differentiation and is closer to the socially efficient location, s_1 and thus the welfare function depends on it as well

$$W(s_1, \lambda) = \frac{3}{4t}(11\lambda - 7)k^2(s_1, \lambda) - 2(2\lambda - 1)A + (1 - \lambda)R \quad (24)$$

In this range, s_1 has a strategic role for the regulator and its selection will affect firms. Policymakers of such political orientation moderately alter the maximum differentiation result of the standard model.

Proposition 4. *For* λ *in* $\left[\frac{3}{5}, 1\right]$ *such that* $max\{s_{11}(\lambda), s_{12}(\lambda)\} \leq -\frac{1}{4}$*, and a reference location* s_1 *in* $[-1/4, 1/2]$*, the optimal tax rate is* $k_3^* = 0$*, with* $A \leq g(k_1^*)$ *where* $g(k_3^*)$ *is given by (19).*

Proof. See appendix

In this upper interval $\left[\frac{3}{5}, 1\right]$ regulators support firms' interests. The rate k_3^* is a constant which value is the lowest of all feasible solutions. The firms' optimal strategies are given by $x_1^* = -1/4$, $x_2^* = 5/4$, regardless of the reference location s_1. Here, differentiation is maximum, and firms have market power. The pro-business regulation regime benefits the firms' interests. Substituting k_3^* in the welfare function we obtain

$$W = -2(2\lambda - 1)A + (1 - \lambda)R \quad (25)$$

The results obtained in Propositions 2 – 4 allow us to segment the political spectrum into three almost equally distributed intervals, given by $I_1 = \left[0, \frac{1}{3}\right]$, $I_2 = \left[\frac{1}{3}, \frac{1}{2}\right[\cup \left]\frac{1}{2}, \frac{3}{5}\right]$ and $I_3 = \left[\frac{3}{5}, 1\right]$, with associated optimal tax rates k_1^*, k_2^* and k_3^* respectively. The results obtained show that the greater the pro-business orientation of regulators, the lower the tax rate applied to them. In the next subsection we seek to determine the optimal reference location s_1^* for the middle range of political orientation since, as has been shown, for the lower and upper political profiles, the reference location, s_1^*, has no influence on firms' behaviour.

5.2. Optimal reference locations

In the last stage, the regulator's optimal reference locations, s_1^*, are determined. As mentioned above, in the pro-consumers' political range $\left[0,\frac{1}{3}\right]$, $s_1^*=\frac{1}{2}$, while in the pro-business range, given by $I_3=\left[\frac{3}{5},1\right]$, s_1^* may be any value in $\left[-\frac{1}{4},\frac{1}{2}\right]$. Focusing on the middle range $I_2=\left[\frac{1}{3},\frac{1}{2}\right[\cup\left]\frac{1}{2},\frac{3}{5}\right]$ and considering the optimal firms' strategies (x_1^*, x_2^*) and the regulator's optimal rate k_2^* optimal s_1 is given by maximising the welfare function, given by equation (24). The optimal regulation locations are specified in Proposition 4.

Proposition 5. *For the optimal rate $k_2^* = k(s_1, \lambda)$, the optimal reference location s_1^* is:*

$$s_1^*=\begin{cases} \frac{1}{2}, & if\ \lambda\in\left[0,\frac{1}{3}\right], \quad A\leq 0 \\ \frac{1}{2}, & if\ \lambda\in\left[\frac{1}{3},\frac{1}{2}\right[, \quad A\leq\frac{3\,t(1-3\lambda)(4\lambda-3)}{4(11\lambda-7)^2} \\ -\frac{1}{4}, & if\ \lambda\in\left]\frac{1}{2},\frac{3}{5}\right], \quad A\leq\frac{3t\,(61\lambda^2-78\lambda+25)}{4\,(11\lambda-7)^2} \\ \left[-\frac{1}{4},\frac{1}{2}\right], & if\ \lambda\in\left[\frac{3}{5},1\right] \quad A\leq\frac{3\,t}{4} \end{cases}$$

Proof. See appendix

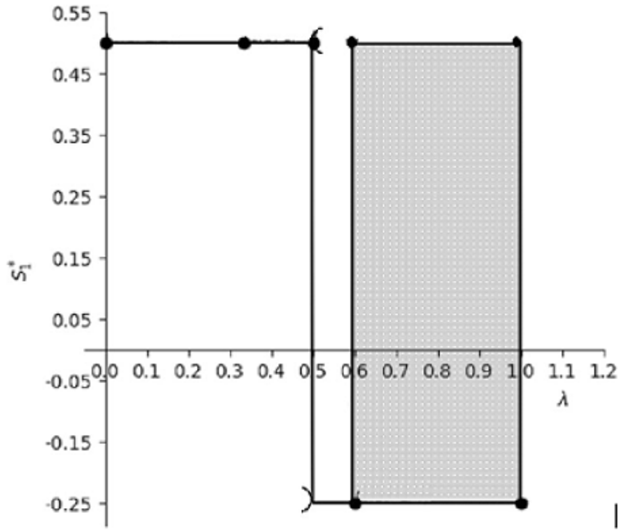
Figure 3 plots the optimal reference location s_1^* for different levels of political affiliation, as λ increases the regulator gets more pro-business. The dashed line, in $\lambda = 1/2$ corresponds to Lambertini (1997) result The following properties can be highlighted.

Property 1. The two types of regulators with bias $\lambda\in\left[\frac{1}{3},\frac{1}{2}\right[$ and $\lambda\in\left]\frac{1}{2},\frac{3}{5}\right]$ have fully opposite location preferences, ranging from minimum differentiation $\left[s_1^*=s_2^*=(\frac{1}{2})\right]$ to maximum $\left[s_1^{**}=-(\frac{1}{4}),\ s_2^{**}=(\frac{5}{4})\right]$, respectively. The inflexion point is given by weight $\lambda = 1/2$.

Property 2. By substituting values of s_1^*, by $(1/2)$ and $(-1/4)$, in equation (18), we obtain respectively:

$$k_2^*(\lambda) = k\left(\frac{1}{2}, \lambda\right) = \frac{t(7\lambda - 4)}{(11\lambda - 7)}, \ k_2^{**}(\lambda) = k\left(-\frac{1}{4}, \lambda\right) = \frac{t(5\lambda - 3)}{(11\lambda - 7)} \tag{26}$$

Figure 3: Optimal regulator's location and degree of political affiliation



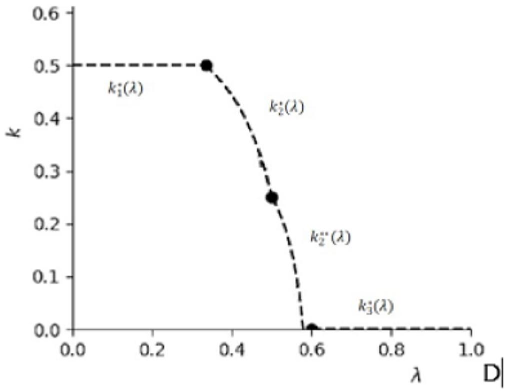
Source: Authors' calculations

The optimal rate $k_2^*(\lambda)$, defined for $\lambda \in \left[\frac{1}{3}, \frac{1}{2}\right[$ approximates the upper value $(t/2)$ as the relative weight on firms λ decreases. Optimal rate $k_2^{**}(\lambda)$ defined for $\lambda \in \left]\frac{1}{2}, \frac{3}{5}\right]$ approaches its lower limit (0), as the bias λ increases. However, as one would expect, the two optimal rates become more moderate as λ s approaches $(1/2)$, and one has

$$\lim_{\lambda \to \left(\frac{1}{2}\right)^-} k_2^*(\lambda) = \lim_{\lambda \to \left(\frac{1}{2}\right)^+} k_2^{**}(\lambda) = \frac{t}{3} \tag{27}$$

To illustrate more clearly the relationship of optimal tax rates with respect to political orientation λ, in the spectrum [0,1], the different functions obtained k_1^*, k_2^*, $k_2^{**}(\lambda)$ and k_3^* are plotted in Figure 4.

Figure 4: Optimal tax rates and degree of political affiliation



Source: Authors' calculations

As shown in Figure 4, as the relative weight, λ increases, i.e., as the weight given to firms by regulators increases, the optimal tax rates decrease. In particular, the decreasing rate is gradually increasing[7]. In other words, Figure 4 shows a coherent pattern between the variation in optimal tax rates and the variation in regulators' relative weight on firms; from more interventionist profiles with high rates of k to those more inclined to *laissez-faire* with low rates.

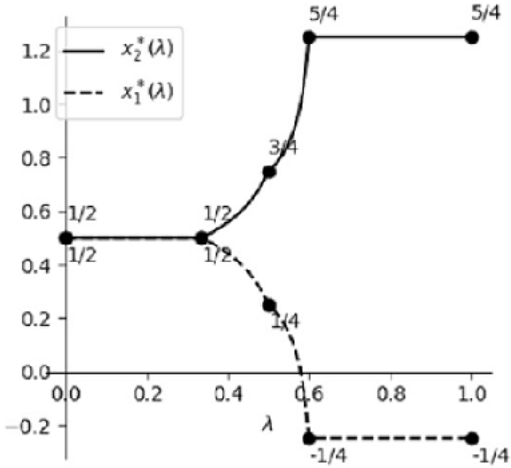
Property 3. By substituting respectively k_1^*, $k_2^*(\lambda)$, $k_2^{**}(\lambda)$ and $k_3^{**}(\lambda)$ into the firms' optimal locations (x_1^*, x_2^*) along the political orientation spectrum [0,1], one obtains the firms' optimal locations as a function of λ only. In other words,

$$x_1^*(\lambda) = \begin{cases} \frac{1}{2} & if\ \lambda \in \left[0, \frac{1}{3}\right] \\ \frac{(31\lambda - 17)}{4\,(11\lambda - 7)} & if\ \lambda \in \left[\frac{1}{3}, \frac{1}{2}\right[\\ \frac{(19\lambda - 11)}{4\,(11\lambda - 7)} & if\ \lambda \in \left]\frac{1}{2}, \frac{3}{5}\right] \\ 0 & if\ \lambda \in \left[\frac{3}{5}, 1\right] \end{cases}$$

And $x_2^*(\lambda)$ can be deduced from the symmetry relation $x_1^*(\lambda) + x_2^*(\lambda) = 1$. Figure 5 depicts the variation of firms' optimal locations $(x_1^*(\lambda), x_2^*(\lambda))$ depending on the political orientation of regulations, assuming that $t = 1$.

[7] The decreasing rate of $k_2^{**}(\lambda)$ is higher than that of $k_2^*(\lambda)$ for $\lambda \in \left[\frac{1}{3}, \frac{1}{2}\right]$

Figure 5: Optimal firms' locations and degree of political affiliation



Source: Authors' calculations

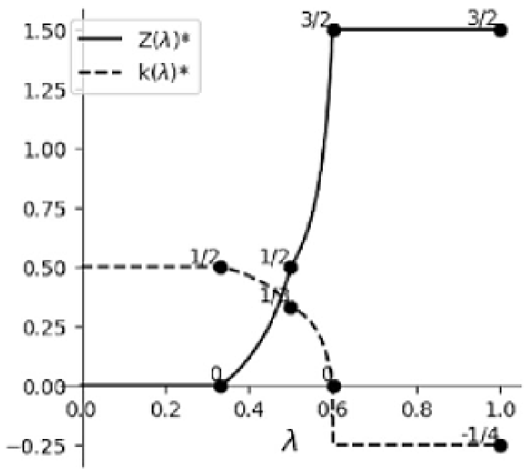
For $\lambda \in \left[0, \frac{1}{3}\right]$, the two optimal location functions $(x_1^*(\lambda), x_2^*(\lambda))$ are equal to $1/2$ in Figure 5. For $\lambda \in \left[\frac{1}{3}, \frac{1}{2}\right[\cup \left]\frac{1}{2}, \frac{3}{5}\right]$, the location of firm 1, $x_1^*(\lambda)$, is a monotonically decreasing function, represented by the dotted curve, and the location of firm 2, $x_2^*(\lambda)$, represented by a solid curve, is increasing. Finally, for $\lambda \in \left[\frac{3}{5}, 1\right]$, $x_1^*(\lambda)$, the dotted line, is constant and equal to $-1/4$ and $x_2^*(\lambda)$, the solid line, is constant and equal to $5/4$. This result is consistent with proposition 1, as well as with Figure 2 and conclusions therein.

Property 4. Product differentiation between firms, as measured by the different in location, $Z^*(\lambda) = x_2^*(\lambda) - x_1^*(\lambda)$, depends on the variation of λ in regulatory political spectrum [0,1], given by

$$Z^*(\lambda) = \begin{cases} 0 & if\ \lambda \in \left[0, \frac{1}{3}\right] \\ \frac{3(1-3\lambda)}{2\,(11\lambda - 7)} & if\ \ \lambda \in \left[\frac{1}{3}, \frac{1}{2}\right[\\ \frac{3(1-\lambda)}{2\,(11\lambda - 7)} & if\ \ \lambda \in \left]\frac{1}{2}, \frac{3}{5}\right] \\ \frac{3}{2} & if\ \ \lambda \in \left[\frac{3}{5}, 1\right] \end{cases}$$

Following the results of proposition 1 in section 3, differentiation Z and tax rate k vary in opposite directions, as also shown below, in Figure 6. Differentiation is observed to increase as the regulator's support towards firms grows. Indeed, in the first segment of the political spectrum $\lambda \in \left[\frac{3}{5}, 1\right]$ in which the policymaker values consumers' well-being more hence it has a more *leftist* political leaning one obtains minimum differentiation. Regulation is more, as reflected in the higher tax rate, which induces firms to locate close to one another and offer lower prices.

Figure 6: Optimal firms' locations and differentiation at different levels of political affiliation



Source: Authors' calculations

In the opposite spectrum where λ belongs to the upper range of $\left[\frac{3}{5}, 1\right]$, maximum differentiation is achieved. The regulator holds a pro-business liberal economic vision in which regulation is minimal (lower taxation on firms) and consumer prices are higher. In the central part of political affiliation, that is $I_2 = \left[\frac{1}{3}, \frac{1}{2}\right[\cup \left]\frac{1}{2}, \frac{3}{5}\right]$ differentiation is moderate, gradually increasing from one extreme to the other. These remarks reinforce all the results obtained previously (Propositions 1 – 4). Thus, our work highlights the importance of policymaker's political leaning in determining both the optimal regulation design and the degree of product differentiation and price structure.

Our main findings have important policy implications and suggest that oligopolistic and regulated markets should not be analysed ignoring political realities, as these may have important distributional consequences. This is evident, for example, in the energy sector and the urgent intervention undertaken by EU member states due to the Ukraine-Russian war in 2021 and 2022. Although a common set of objectives and strategies were identified at the EU level, particularities were also observed. Putting granularities aside, direct government intervention to control prices for consumers took, among other things, the form of price caps or producer subsidies. However, many policymakers presume that price caps interfere with market forces. Another intervention included the payment of cash benefits to different vulnerable groups of society. Different countries selected a different policy mix and this may reflect distinct political positions and economic visions, which is the main argument of our paper. The distributional implications are different. For example, Germany and the Netherlands to maintain the price signal and encourage households and firms to save energy, adopted a *tiering* mechanism, subsidising households' and firms' consumption up to a maximum volume. Spain and Portugal introduced a measure known as the *Iberian mechanism* which consisted of price capping and subsidising electricity producers' gas purchases to limit price rises for end-consumers (Carluccio et al., 2024; Sgaravatti et al., 2021). The health sector, although it entails a mixed (public and private health providers) oligopolistic setting is another regulated sector in which the design of regulation and the market outcomes vary tremendously depending on policymakers' political preferences (see for example, Kooshkebaghi et al. (2022) or Trottmann et al. (2023)).

6. Conclusion

In a spatial duopoly based on the approach by D'Aspermont et al. (1979), we consider a politically charged fiscal authority that implements a taxation/subsidization system in order to induce firms to select their reference locations. Political orientation is formalised through varying weighting factors assigned to firms' and consumers' interests. This is formulated through a weighted welfare function as a linear combination of economic agents' surpluses. In other words, we analyse the regulation effects on firms' equilibrium location, obtaining that product differentiation varies according to the fiscal profile, from minimum to maximum, through moderate differentiation. Besides, we determine relationships between the regulator's political considerations, its preferred locations, chosen fiscal regime and firms' optimal locations.

The results obtained enable us to identify three regulation profile ranges, somewhat equally distributed along the possible spectrum of political orientation. The first range gives a higher weight to consumers and corresponds to pro-consumer interventionist regulators. Relying on the highest possible tax rate, the regulators propose the centre as the ideal firms' location. Fiscal policy successfully achieves its objectives, leading firms to locate at the market centre. The resulting differentiation is minimal due to the threat of taxation. This intensifies competition and reduces prices to zero. In the second range, corresponding to the middle zone of political affiliation and most moderate regulatory profiles, the optimal tax rate is decreasing and differentiation increasing with respect to λ, so firms' position is improved at the expense of consumers as political affiliation approaches more liberal positions. Within this range, two different cases can be distinguished. First, if regulators are moderately inclined to the left of the spectrum (towards consumers), they prefer firms locating in the market centre. However, they do not succeed at inducing firms to follow and the equilibrium result is moderate firms' differentiation. Second, regulators with a moderately free-market oriented profile choose reference locations at the extremes of the market. Again, they do not, however, achieve this and the equilibrium result is also moderate, although the differentiation obtained is greater than in the previous case. Finally, regulators within the upper range can be thought of as the most pro-business liberal ones, apply a nil tax rate, so their fiscal scheme is limited to the lump-sum transfer, which they may use to pursue interests other than location (such as revenues, and so on). In particular, under this political profile range, no reference location is determined, letting firms free to choose their location. The result is maximum differentiation, coinciding with equilibrium in the absence of regulation.

This work generalises Lambertini's (1997) approach, which considers a *neutral* policymaker, choosing socially efficient locations. While firms prefer to differentiate in order to relax competition and increase profits, consumers prefer strong price competition which reduces prices and increases their surplus. The optimal normative position is centrally located between extremes, considered both *neutral* and *socially optimal*. Nonetheless, a neutral stance on fiscal policy may not always occur in practice. Either due to electoral objectives, lobbying interests or ideology, policymakers have distinct political orientations and these are inevitably reflected on the regulatory schemes they put forth. The weight given to consumers or firms plays a fundamental role in policy schemes designed and in the resulting principle of differentiation undertaken by firms. Our work offers a political economy approach to regulation within duopolistic settings allowing for more realistic fiscal profiles and corresponding market results to be explored.

Notwithstanding, limitations remain and potential avenues for future research can be identified. First, we may reconfigure the assumption that the consumer´s and regulator´s surpluses coincide and explicitly allow for a separate component attached solely to the public sector. This way we can account for a more enriched political environment, to which we can add political or electoral considerations. Further elements that can both enhance the theoretical setting and make it more realistic would entail the incorporation of a more complex (and non-linear) tax/subsidy structure, corporate social responsibility (CSR), new technologies and information asymmetry. Second, the model's applicability could be broadened by considering an oligopolistic market with more than two firms. The current duopoly framework, while insightful, does not capture the competitive interactions and strategic behaviours that emerge in markets with multiple oligopolistic players. Extending the model to include a greater number of firms would provide a more comprehensive understanding of how fiscal regulation and political orientation influence market outcomes, and reflect better the ample presence of oligopolistic markets in the real world. Third, this work could benefit greatly from a more profound empirical front. Matching our theoretical model and predictions with an applied counterpart would be a fruitful future avenue.

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Appendix

Proof of proposition 1

Proof. The location equilibrium is determined by simultaneously maximising the profit functions (11) and (12) with respect to x_1 and x_2.Solving the first-order conditions,

$$\frac{\partial B_1(x_1, x_2, s_1)}{\partial x_1} = \frac{t}{18}\{(2 + x_1 + x_1)(x_2 - 3x_1 - 2)\} + k = 0$$

$$\frac{\partial B_2(x_1, x_2, s_1)}{\partial x_2} = \frac{t}{18}\{(4 - x_1 - x_2)(4 + x_1 - 3x_2)\} + k = 0,$$

the following solution is obtained:

$$x_1^* = -\frac{1}{4} + \frac{3k}{2t}, \quad x_2^* = \frac{5}{4} - \frac{3k}{2t}.$$

It is verified that sufficient conditions are satisfied, moreover:

$$x_1^* + x_2^* = 1\,, \; x_2^* - x_1^* = (3/2t)\,(t - 2k)$$

So that

$$x_2^* \geq x_1^* \quad \Leftrightarrow \quad 0 \leq k \leq \frac{t}{2}.$$

Substituting optimal (x_1^*, x_2^*) into the profit functions (11) and (12), and considering that $s_1 + s_2 = 1$, the firms' profits are given by $B_i^*(k, s_1) = \frac{1}{4t}[6k^2 - kt(4s_1 + 7) + 3t^2] - A;\ i = 1, 2$, thus, it is verified that profits are non-negative for $A \leq g(k, s_1)$, where $g(k, s_1) = \frac{1}{4t}[6k^2 - kt(4s_1 + 7) + 3t^2]$. Similarly, substituting (x_1^*, x_2^*) into equation (5) the fiscal scheme becomes

$$T_i^*(k, s_1) = \frac{1}{4t}[-6k^2 + kt(4s_1 + 1) + 4At]; \qquad i = 1,2$$

In other words, T_i is positive if $A > h(k, s_1)$, where $h(k, s_1) = \frac{k}{4t}[6k - t(4s_1 + 1)]$. It follows that firms are being taxed if $A \in]h(k, s_1), g(k, s_1)]$ and they are being subsidised if $A \in]-\infty, h(k, s_1)]$.

Proof of proposition 2

Proof. For any $\lambda \in \left[0, \frac{1}{3}\right]$, it can be verified that $s_{11}(\lambda) \leq -\frac{1}{4} \leq s_{12}(\lambda) \leq \frac{1}{2}$, hence there are two alternatives. First, for any $s_1 \in \left[-\frac{1}{4}, s_{12}(\lambda)\right]$, by solving the first order conditions of the welfare maximisation problem given by expression (17), one obtains the interior solution

$$Arg \underbrace{max}_{k\in\left[0,\frac{t}{2}\right]} W = k_2^* = k(s_1, \lambda) = \frac{t}{3(11\lambda - 7)}[4(2\lambda - 1)s_1 + (17\lambda - 10)]$$

The second order condition is fulfilled. Second, for any $s_1 \in \left[s_{12}(\lambda), \frac{1}{2}\right]$, it holds that $k(s_1, \lambda) \geq \frac{t}{2}$, obtaining the corner solution

$$Arg \underbrace{max}_{k\in\left[0,\frac{t}{2}\right]} W = k_1^* = \frac{t}{2}.$$

However, substituting respectively k_1^* and k_2^* in the welfare function W, it is easily verified that

$$W(k_1^*) \geq W(k_2^*)$$

Substituting k for k_1^* n the inequality of proposition 1, it is obtained that $A \leq \frac{t}{2}(1 - 2s_1)$.

Thus, for any $\lambda \in \left[0, \frac{1}{3}\right]$ and $A \leq \frac{t}{2}(1 - 2s_1)$, the optimal tax rate is given by $k_1^* = \frac{t}{2}$.

Proof of proposition 3

Proof. For any $\lambda \in \left[\frac{1}{3}, \frac{1}{2}\right[\cup \left]\frac{1}{2}, \frac{3}{5}\right]$, with $min\,\{s_{11}(\lambda), s_{12}(\lambda)\} \leq -\frac{1}{4} \leq Max\left\{s_{11}(\lambda), s_{12}(\lambda), \frac{1}{2}\right\}$ there are several possibilities.

First, for any $\lambda \in \left[\frac{1}{3}, \frac{1}{2}\right[$, we have $s_{11}(\lambda) < s_{12}(\lambda)$ and $\left[-\frac{1}{4}, \frac{1}{2}\right] \subseteq [s_{11}(\lambda), s_{12}(\lambda)]$, thus for any $s_1 \in \left[-\frac{1}{4}, \frac{1}{2}\right]$, solving the first order conditions of the welfare function maximisation the interior solution is obtained and is given by $k_2^* = k(s_1, \lambda)$ corresponding to the equation (18) in the main text.

For $\lambda \in \left]\frac{1}{2},\frac{3}{5}\right]$, contrary to the first case, we have $s_{12}(\lambda) < s_{11}(\lambda)$, and since we can have $s_{12}(\lambda) \leq -\frac{1}{4} \leq \frac{1}{2} \leq s_{11}(\lambda)$, for $\lambda \in \left]\frac{1}{2},\frac{4}{7}\right]$ and $s_{12}(\lambda) \leq -\frac{1}{4} \leq s_{11}(\lambda) \leq \frac{1}{2}$, there are two cases:

In the first case, when $\lambda \in \left]\frac{1}{2},\frac{4}{7}\right]$, for any $s_1 \in \left[-\frac{1}{4},\frac{1}{2}\right]$, the solution is again given by $k_2^* = k(s_1,\lambda)$. In the second case in which $\lambda \in \left[\frac{4}{7},\frac{3}{5}\right]$. In this scenario, we have two alternatives.

- for any $s_1 \in \left[-\frac{1}{4}, s_{11}(\lambda)\right]$, $\quad Arg \underbrace{max}_{k\in\left[0,\frac{t}{2}\right]} W = k_2^* = k(s_1,\lambda)$,
- for any $s_1 \in \left[s_{12}(\lambda), \frac{1}{2}\right]$, $\quad Arg \underbrace{max}_{k\in\left[0,\frac{t}{2}\right]} W = k_3^* = 0$.

Substituting respectively k_1^* and k_2^* in the welfare function W, it is verified that

$$W(k_2^*) \geq W(k_3^*).$$

Consequently, for any $\lambda \in \left[\frac{1}{3},\frac{1}{2}\right[\cup \left]\frac{1}{2},\frac{4}{7}\right] \cup \left[\frac{4}{7},\frac{3}{5}\right]$ and $A \leq g(k_2^*)$, where $g(k_2^*)$ is given in (18) the optimal tax rate is $k_2^* = k(s_1,\lambda)$.

Proof of proposition 4

Proof. For any $\in [3/5,\ 1]$:

First, we have $s_{12}(\lambda) \leq s_{11}(\lambda) \leq -\frac{1}{4}$, for $\lambda \in \left[\frac{3}{5},\frac{7}{11}\right[$ and $k(s_1,\lambda) < 0$, thus

$$Arg \underbrace{max}_{k\in\left[0,\frac{t}{2}\right]} W = k_3^* = 0$$

And the second order condition of W maximisation is fulfilled.

Second, when $s_{11}(\lambda) \leq s_{12}(\lambda) \leq -\frac{1}{4}$, for $\lambda \in \left]\frac{7}{11},1\right]$, $k(s_1,\lambda) > t/2$ and is a minimum, thus

$$Arg \underbrace{max}_{k\in\left[0,\frac{t}{2}\right]} W = k_3^* = 0$$

Therefore for any $\lambda \in \left[\frac{3}{5}, \frac{7}{11}\right[\cup \left]\frac{7}{11}, 1\right]$ and $A \leq g(k_3^*) = (3t/4)$, the optimal tax rate is $k_3^* = 0$

If $\lambda = \frac{7}{11}$, the welfare function W can be expressed as

$$W = -\frac{1}{2}[4(2\lambda - 1)s_1 + (17\lambda - 10)]k - 2(2\lambda - 1)A + (1 - \lambda)R$$

Thus, again $Arg \underbrace{max}_{k \in \left[0, \frac{t}{2}\right]} W = k_3^* = 0$

Finally, for any $\in [3/5,\ 1]$, the optimal tax rate is given by $k_3^* = 0$.

Proof of proposition 5

Proof. As seen in subsection 4.1, for the range of $\lambda \in \left[0, \frac{1}{3}\right]$, s_1^* is equal to $\frac{1}{2}$ and in the range $\left[\frac{3}{5}, 1\right]$ regulator's optimal reference location s_1^* can be any value in $\left[-\frac{1}{4},\ \frac{1}{2}\right]$. Therefore, here, we focus on the interval $\left[\frac{1}{3}, \frac{1}{2}\right[\cup \left]\frac{1}{2}, \frac{3}{5}\right]$.

For $\lambda \in [1/3, 1/2[$, the optimal tax rate is $k_2^* = k(s_1, \lambda)$, strictly greater than zero,

$$\frac{\partial W}{\partial s_1} = -2\ (2\lambda - 1)\ k(s_1, \lambda) \geq 0 \qquad and \qquad Arg \underbrace{max}_{s_1 \in \left[-\frac{1}{4},\ \frac{1}{2}\right]} W = \frac{1}{2} = s_1^*$$

The constraint corresponding to $A \leq g(k_2^*)$, is verified for:

$$A \leq \frac{3\ t(1 - 3\lambda)(4\lambda - 3)}{4(11\lambda - 7)^2}.$$

For $\lambda \in]1/2, 3/5]$, the optimal rate is still $k_2^* = k\ (s_1, \lambda)$ although in this instance

$$\frac{\partial W}{\partial s_1} = -2\ (2\lambda - 1)\ k(s_1, \lambda) \leq 0 \qquad and \qquad Arg \underbrace{Max}_{s_1 \in \left[-\frac{1}{4},\ \frac{1}{2}\right]} W = -\frac{1}{4} = s_1^*$$

The constraint corresponding to $A \leq g(k_2^*)$, is verified for:

$$A \leq \frac{3t\ (61\lambda^2 - 78\lambda + 25)}{4\ (11\lambda - 7)^2}.$$

Politička razmatranja i fiskalna regulacija unutar prostornog duopola: Učinci na diferencijaciju proizvoda

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Sažetak

U ovom radu ispituje se utjecaj političke orijentacije na fiskalnu regulaciju i diferencijaciju proizvoda unutar prostornog duopola. Koristeći pristup modeliranja a la Hotelling, istražujemo kako političko stajalište regulatora – bilo da je usmjereno na potrošače ili poslovanje – utječe na tržišne rezultate kroz različite optimalne fiskalne intervencije. Identificirali smo tri regulatorna profila: (i) regulacija u korist potrošača s visokim poreznim stopama koje dovode do minimalne diferencijacije proizvoda i nižih cijena; (ii) pro-poslovna regulacija bez oporezivanja što rezultira maksimalnom diferencijacijom proizvoda i višim cijenama, i (iii) umjerena regulacija, koja balansira interese tvrtki i potrošača, u kojoj porezi mogu biti umjereni, ali tvrtke nisu stimulirane da slijede naznačene razine diferencijacije regulatora. Rezultati našeg istraživanja ističu značajnu ulogu političke orijentacije u oblikovanju tržišne dinamike i regulatorne učinkovitosti pritom naglašavajući potrebu razmatranja političkih čimbenika i balansiranja različitih aktera u kreiranju politike unutar modela prostornog natjecanja.

Ključne riječi: *optimalna fiskalna politika, diferencijacija proizvoda, regulacija i politička pripadnost u oligopolističkom okruženju*

JEL klasifikacija: *L13, L50, R32, H21, C72*

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