Stability of the Cournot–Ricardo Solution under Domestic Free Movement of Labor *

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August 13, 2014

Abstract

This paper proves the non–stability of monopolistic competitive solution if workers move from low to high profit industries. Thus, the labor rationality matters, since these movements are shown to contribute to increase the degree of international competitiveness. However, the properties of that convergence depend on the characteristics of the labor market. In that, if workers of only one country can move, the convergence to the competitive Ricardo–Mill solution strongly depends on which country is assumed to have free movement of workers. Also, if workers of both countries can freely move, that solution does not converge. In conclusion, under inter–industry movement of labor, economies reach a specialization which could not coincide with that predicted by the competitive solution.

Keywords: Ricardo–Mill, Ricardo–Cournot, Intra–Industry, Labor Mobility
JEL Codes: C62, F11, F22, J61

1 Introduction

The Ricardo–Mill theory of the Comparative Advantage is a very powerful tool to describe the international distribution of production, and an elegant argument supporting free trade. Nevertheless, the competitive equilibrium does not have a known dynamic given the "general price uncertainty" resulting from the time–consuming nature of productive process: when the productive process is planned, industries do not know the price that will prevail, while the production is not available in the world markets (Ruffin, 1974). Consequently, the Comparative

*This research was supported by the Escuela Politécnica Nacional, Ecuador

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Advantage theory cannot explain how economies are driven out from the autarkical equilibrium to the free trade competitive equilibrium (Dixit and Norman, 1980).

Later, the Cournot–Ricardo monopolistic competition model (Song and Sohn, 2012), is introduced in the international trade analysis with the aim of studying inter–industry trade. This model emerges as an interesting proposal to solve this "general price uncertainty", since the relative factor price is known at the Cournot equilibrium, and the comparative advantage is well defined at this price. However, assuming the same conditions of Song and Sohn (2012) model, the Cournot–Ricardo equilibrium is dynamically stable only under very strong conditions: workers cannot change jobs or industries do not react to these labor movements. The former assumption is unreal and unacceptable, since it violates the international labor rules; and, the later is irrational, given the strategic behavior of industries.

This paper shows that workers have incentives to leave the less profitable industries in the Cournot–Ricardo model. The direction of these movements is known: workers leave industries without comparative advantage and seek for new jobs in the industries with the largest comparative advantage. Consequently, if these inter–industry movements reduce the size of industries without comparative advantage, then the Cournot–Ricardo model seems to lead economies to the competitive equilibrium. However, this paper shows that the convergence to the competitive relative labor price strongly depends on which country is assumed to have free movement of workers: if industries react simultaneously to the change in the level of production, given these inter–industry movements, the equilibrium does not exist; but, assuming that workers can move inside one country only, this paper proves that the equilibrium exists in such a case.

In conclusion, labor market conditions strongly determine the properties of the equilibrium. In the case of the Cournot–Ricardo model, the assumptions related to the inter–industry movement of labor determine important properties of the model, such as the convergence to the competitive equilibrium, or can even determine the existence of the equilibrium.

The next sections of the paper is organized as follows: Section 2 analyzes the general theoretical framework and the properties of the Competitive and Cournot solutions; Section 3 analyzes the incentives for the freedom of labor movements and the convergence in prices under different conditions of inter–industry movement. Finally, Section 4 exposes the conclusions obtained from the previous sections.

2 Theoretical framework

This paper assumes the general framework of the Ricardo–Mill model with a continuum of goods (Dornbusch et al., 1977; Wilson, 1980). Let $c = 1, 2$ denote countries; t, time periods; and, $z \in Z = [0, 1] \subseteq \mathbb{R}$, commodities. The notation c' is used to define "the other country".

Condition 2.1 (Technology)**.** *Each commodity z produced in country c uses a fixed amount of labor $a^c(z)$ per unit of output. The function $a^c(z)$ satisfies the following conditions: a) it is differentiable, strictly positive (non free lunch) and, it exhibits constant return to scale technology; b) it does not depend on time t; and, c) the relative fixed labor requirement, $a(z) = a^1(z)/a^2(z)$ is a strictly increasing function.*

Under Condition 2.1, each industry z produces $x^c(z, t) = \ell^c(z, t)/a^c(z)$ units of output, given $\ell^c(z, t)$, the labor demand of industry z and country c. Also, $a(z)$ ranks industries by the relative fixed labor requirement to produce a commodity z.

Condition 2.2 (Consumers). *The L^c consumers satisfy the following conditions: a) they are identical in preferences; b) the preferences admit to be represented by the Cobb–Douglas utility function; c) each individual is endowed with* 1 *unit of labor, which is supplied inelastically at the price $\omega^c(t)$; and, d) the income $m^c(z,t)$ of an individual working in the industry z in country c is equal to the per–worker participation in profits $\pi^c(z,t)$, added to the salary, $\omega^c(t)$.*

Under Condition 2.2*a*) and, 2.2*b*), the total demand of the commodity z is $x(z,t) = M(t)\alpha(z)/p(z,t)$, where $p(z,t)$ denotes the commodity price, and $M(t) = \sum_c \int_0^1 m^c(z,t)dz$, the worldwide income. The Condition 2.2*b*) ensures that the proportion of the worldwide income expended in each commodity, $\alpha(z)$, depends only on z. Also, the Condition 2.2*c*) and 2.2*d*), guarantee that any individual working in the industry z in country c has the same individual income, $m^c(z,t)$. Nevertheless, this equality could not hold if individuals work in different industries.

2.1 Properties of the Competitive and Cournot Solutions

Definition 2.1 (Comparative Advantage). *An industry z located in country c has comparative advantage relatively to the country c', if $\omega^c a^c(z) \leq \omega^{c'} a^{c'}(z)$. If the inequality is strict, the comparative advantage is strict.*

Theorem 2.1 (Competitive solution (Dornbusch et al., 1977)). *Under Condition 2.1 and 2.2, the competitive equilibrium is the relative factor price $\omega(t) = \omega^1(t)/\omega^2(t)$ that satisfies:*

$$\omega(t) = \frac{\int_0^{\bar{z}} \alpha(z)dz}{1 - \int_0^{\bar{z}} \alpha(z)dz} \frac{L^2}{L^1} = B(z, L^2/L^1) \tag{1}$$

for $\bar{z} = a^{-1}(\omega(t))$ and, commodity price, $p(z,t) = \min\{\omega^1(t)a^1(z), \omega^2(t)a^2(z)\}$. The industry $\bar{z}$ defines the geographic distribution of production according to the comparative advantage: industries without comparative advantage close, or equivalently, countries are specialized in the production of commodities with strict comparative advantage.

Definition 2.2 (Reaction Function). *The function that gives the production level that maximizes profits of the industry z located in country c, for a given production level of the industry z located in country c' is called the reaction function:*

$$R^c(z,t;x^{c'}) = \underset{x^c}{argmax}\{p(z,t)x^c(z,t) - \ell^c(z,t)\omega^c(t)\}. \tag{2}$$

Theorem 2.2 (Cournot solution (Song and Sohn, 2012)). *Under conditions 2.1 and 2.2, the Cournot equilibrium is the relative factor price $\omega(t) = L^2/L^2$ and commodity prices $p(z,t) = \omega^1(t)a^1(z) + \omega^2(t)a^2(z)$ such that $R^c(z,t;R^{c'})$. Under this equilibrium, countries do not specialize in the production of any commodity.*

Proposition 2.1 (Properties of the Reaction Function). *Under Condition 2.1 and 2.2, the reaction function $R^c(z,t;x^{c'})$ satisfies the following properties:*

P.1. $R^c(z,t;x^{c'}) > 0$, if and only if $x^{c'}(z,t) \in \left(0, \frac{M(t)\alpha(z)}{a^c(z)\omega^c(t)}\right)$.

P.2. $R^c(z,t;x^{c'})$ *is a non–increasing function in* $x^{c'}$ *if* $x^{c'}(z,t) \geq \frac{M(t)\alpha(z)}{4a^c(z)\omega^c(t)}$ *and non–decreasing otherwise.*

P.3. If $x^{c'}(z,t) = R^{c'}(z,t;R^c)$ *it satisfies* $R^c(z,t;R^{c'}) = \frac{M(t)\alpha(z)\omega^c(t)a^c(z)}{(\omega^1(t)a^1(z)+\omega^2(t)a^2(z))^2}$.

Proof 2.1. *Under conditions 2.1 and 2.2, the reaction function* $R^c(z,t;x^{c'})$ *can be found by solving the maximization problem described in Equation (2):*

$$R^c(z,t;x^{c'}) = \left(M(t)\alpha(z)x^{c'}(z,t)\right)^{1/2}\left(\omega^c(t)a^c(z)\right)^{-1/2} - x^{c'}(z,t). \tag{3}$$

The property P.1. is obtained from the algebraic manipulation of Equation (3) for $R^c(z,t;x^{c'}) > 0$. *Solving the equation* $\partial R^c/\partial x^{c'} = 0$, *and* $\partial^2 R^c/\partial^2 x^{c'} < 0$, *the reaction function attains the maximum at* $x^{c'}(z,t) = M(t)\alpha(z)/(4a^c(z)\omega^c(t))$ *and P.2 holds for all z, since this maximum is strict and global. Solving Equation (3) for* $x^{c'} = R^{c'}$, *it satisfies P.3* ■

Proposition 2.2. *If* $x^1(z,t) = R^1(z,t;x^2)$ *and* $x^2(z,t) = R^2(z,t;x^1)$ *holds simultaneously, the labor demands satisfy the following relation* $\ell^2(z,t) = \omega(t)\ell^1(z,t)$.

Proof 2.2. *Since the reaction functions hold simultaneously, the total production satisfies* $x(z,t) = R^1(z,t;x^2) + x^2(z,t)$ *and, by symmetry,* $x(z,t) = R^2(z,t;x^1) + x^1(z,t)$. *Plugging in Equation (3), the relation* $x^c(z,t) = \ell^c(z,t)/a^c(z)$ *given by Condition 2.1, and manipulating terms it holds* $\ell^2(z,t) = \omega(t)\ell^1(z,t)$ ■

Proposition 2.3. *Under Condition 2.1 and 2.2, the reaction function* $R^c(z,t;x^{c'})$ *is non–increasing in the Cournot equilibrium if country* c' *has comparative advantage in the production of z.*

Proof 2.3. *Given the Definition 2.2 of reaction function, by the Theorem 2.2, the production level satisfies simultaneously* $x^c(z,t) = R^c(z,t;R^{c'})$, *and* $x^{c'}(z,t) = R^{c'}(z,t;R^c)$ *at the Cournot equilibrium, then by Proposition 2.1–P.3 it holds:*

$$R^{c'}(z,t;R^c) \geq \frac{M(t)\alpha(z)\omega^c(t)a^c(z)}{(2\omega^c(t)a^c(z))^2} = \frac{M(t)\alpha(z)}{4\omega^c(t)a^c(z)}, \tag{4}$$

since $\omega^1(t)a^1(z) + \omega^2(t)a^2(z) \leq 2\omega^c(t)a^c(z)$ *if* c' *has comparative advantage.*

The last term of the inequality (4) coincides with the property P.2 given by Proposition 2.1. Then, if country c' *has comparative advantage, according to Definition 2.1, the reaction function* $R^c(z,t;R^{c'})$ *is non–increasing in the Cournot solution* ■

3 The incentives to the inter–industry movements

Proposition 3.1. *Under Condition 2.1 and 2.2 the individual income* $m^c(z,t)$ *is:*

$$m^c(z,t) = \pi^c(z,t) + \omega^c(t) = \frac{p(z,t)}{a^c(z)} \tag{5}$$

Proof 3.1. *The total profit of the industry z and country c is $\Pi^c(z,t) = p(z,t)x^c(z,t) - \omega(t)\ell^c(z,t)$. And, under Condition 2.1, $x^c(z,t) = \ell^c(z,t)/a^c(z)$, profits can be written as a function of the labor employed in the production, $\Pi^c(z,t) = p(z,t)\ell^c(z,t)/a^c(z) - \omega(t)\ell^c(z,t)$. Under Condition 2.2c), each worker supply exactly one unit of labor, and $\pi^c(z,t) = \Pi(z,t)/\ell^c(z,t)$ is the per–worker participation in profits. Substituting $\pi^c(z,t) = p(z,t)/a^c(z) - \omega(t)$ in the definition of individual income, $m^c(z,t) = \pi^c(z,t) + \omega^c(t)$, we find $m^c(z,t) = p(z,t)/a^c(z)$* ■

Proposition 3.2 (Inter–industry difference in income)**.** *Under the perfect competitive solution, for all z and $z \pm \delta$ industries with comparative advantage, it satisfies that:*

$$m^c(z,t) - m^c(z \pm \delta, t) = 0. \tag{6}$$

And, under the Cournot solution, for all $\delta^c = -(-1)^c\delta$ such that $z + \delta^c \in (0,1)$ and $\delta > 0$,

$$m^c(z,t) - m^c(z+\delta^c, t) = \omega^{c\prime}(t)\left(\frac{a^{c\prime}(z)}{a^c(z)} - \frac{a^{c\prime}(z+\delta^c)}{a^c(z+\delta^c)}\right) > 0. \tag{7}$$

Proof 3.2. *Under conditions 2.1 and 2.2, the Theorem 2.1 shows that $p^c(z,t) = \omega^c(t)a^c(z)$ for all z and $z \pm \delta$ industries with comparative advantage. Then, using the result of Proposition 3.1, the income $m^c(z,t) = m^c(z \pm \delta, t) = \omega^c(t)$, and $m^c(z,t) - m^c(z \pm \delta^c, t) = 0$ for all z and $z \pm \delta$ industries with comparative advantage.*

The proof for the Cournot solution uses the results of Theorem 2.2. This theorem shows that $p(z,t) = \omega^1(t)a^1(z) + \omega^2(t)a^2(z)$. Then, using the result of Proposition 3.1 the individual income is:

$$m^c(z,t) = \frac{p(z,t)}{a^c(z)} = \frac{\omega^1(t)a^1(z) + \omega^2(t)a^2(z)}{a^c(z)} = \omega^{c\prime}(t)\left(\frac{\omega^c(t)}{\omega^{c\prime}(t)} + \frac{a^{c\prime}(z)}{a^c(z)}\right). \tag{8}$$

The result of Equation (8) proofs that $m^c(z,t) - m^c(z+\delta^c, t)$ satisfies the first part of Equation (7). The inequality can be proved observing that $a(z) = a^1(z)/a^2(z)$ is strictly increasing under Condition 2.1, then, for all $z+\delta$ such that $z+\delta \in (0,1)$, and $\delta > 0$, the $1/a(z) > 1/a(z+\delta)$, and the inequality holds for $c = 1$. Also, since $a(z)$ is strictly increasing, then, for all $z - \delta$ such that $z - \delta \in (0,1)$ and $\delta > 0$, it satisfies $a(z) > a(z-\delta)$, and the inequality holds for $c = 2$ ■

Condition 3.1 (Inter–industry freedom)**.** *Individuals can seek freely a new job in other national industries, but cannot be hired by foreign industries, i.e. the international migration is forbidden.*

The following corollary is a general result for the inter–industry movements, where the Condition 3.1 is a fundamental piece of the macroeconomic general equilibrium theory: the labor rationality matters.

Corolary 3.1. *Under Condition 2.1, 2.2 and 3.1 workers do not have incentives to move in the Ricardo–Mill solution, and the solution is dynamically stable; but, the Cournot–Ricardo solution is not dynamically stable if workers have freedom to move from an industry to another with higher profits.*

Since the set Z is uncountable, industries are not well defined. The following assumption solves this problem by assuming that workers move in a set with well define integrals[1].

Assumption 3.1. *For a given $\delta < a^{-1}(L^2/L^1)$, workers have incentives to move in a set of industries $I_R(\delta) = [0, \delta] \cup [1-\delta, 1]$, and workers in the set of industries $I_S(\delta) = (\delta, 1-\delta)$ do not have any incentives to move inside or outside these industries.*

Additionally, Assumption 3.1 guarantee that industries $z \in [0, \delta]$ in Country 1 and industries $z \in [1-\delta, 1]$ in Country 2, have strict comparative advantage at the Cournot equilibrium $\omega(t) = L^2/L^1$. Then, it holds that $\delta < a^{-1}(L^2/L^1)$ and, consequently, the reaction function $R^c(z, t; x^{c\prime})$ is non–increasing in $x^{c\prime}(z, t)$ by immediate application of Proposition 2.3

3.1 Symmetric movement

In the previous section, we show that workers have incentives to switch jobs and these incentives depend exclusively on technology. Besides, the incentives disappear if economies are in (or converges to) the perfectly competitive equilibrium. This section analyzes the properties of the Cournot–Ricardo model under the symmetric inter–industry movement of labor. Countries are assumed to be symmetric if Condition 3.1 applies to both countries. Nevertheless, the symmetric case has two different interpretations, according to the strategies followed by workers and industries.

We can consider the case in which industries cannot decide the amount of labor to be hired: the size of the industry is decided by workers and the relevant strategy is to leave an industry until the gains from the movement is positive. In such a case, the industrial strategy is internationally symmetric, but independent from workers'strategies.

Proposition 3.3 (Symmetric Independent Strategy)**.** *Under Condition 2.1, 2.2 and 3.1, if at $t = 0$ countries are in the Cournot equilibrium, and at $t > 0$ workers seek for a new job according to Assumption 3.1, the relative price of labor is $\omega(t) = L^2/L^1$ for all $t \geq 0$.*

Proof 3.3. *Under Assumption 3.1, workers move from/to industries $z \in I_R(\delta)$. Since the strategies of industries and workers are independent, the $z \in I_R(\delta)$ industries cannot decide the amount of labor to be hired (or fired). Therefore, the labor demand of these industries is $\ell^c(z, t) = \ell^c(z, 0) + d\ell^c(z, t)$, since $d\ell^c(z, t)$ —the amount of labor hired (or taken)— is a scalar exogenously determined. The $z \in I_S(\delta)$ industries are under the Cournot rules. Thus the labor demand $\ell^c(z, t)$ for $z \in I_S(\delta)$, depends on $\omega(t)$.*

Given the total supply of labor, L^c, the labor market equilibrium equation is:

$$L^c = \int_{I_R(\delta)} (\ell^c(z, 0) + d\ell^c(z, t))\, dz + \int_{I_S(\delta)} \ell^c(z, t) dz \tag{9}$$

Since all workers find a new job in some of the $z \in I_R(\delta)$ industry, $\int_{I_R(\delta)} d\ell^c(z, t) dz = 0$. Hence, the Equation (9) does not depend on $d\ell^c(z, t)$:

$$L^c = \int_{I_R(\delta)} \ell^c(z, 0) dz + \int_{I_S(\delta)} \ell^c(z, t) dz \tag{10}$$

[1]Some integrals are calculated in the interior of closed sets. Since these integrals exist in the closed set, then the integral also exist in the interior of the closed set.

Using the result of Proposition 2.2, $\ell^2(z,t) = \omega(t)\ell^1(z,t)$ for $t = 0$ or $z \in I_S(\delta)$ for all $t > 0$. Also, $\omega(0) = L^2/L^1$ at $t = 0$ by Theorem 2.2. Plugging these results in Equation (10), the following relation holds for all $t \geq 0$:

$$\frac{\omega(0)L^1 - \omega(0)\int_{I_R(\delta)} \ell^1(z,0)dz}{L^1 - \int_{I_R(\delta)} \ell^1(z,0)dz} = \omega(t)\frac{\int_{I_S(\delta)} \ell^1(z,t)dz}{\int_{I_S(\delta)} \ell^1(z,t)dz} \tag{11}$$

and, the equality $\omega(0) = \omega(t)$ holds for all $t \geq 0$ ■

A symmetric and independent strategy seems to be an unreal case, since it does not make sense that industries do not react to the inter–industry movement of labor. Then, let consider the symmetric and interdependent case. In such a case, an industry $z \in I_R(\delta)$ can decide strategically the amount of labor to be hired (or fired), taking into account the the amount of labor hired (or fired) by the same industry $z \in I_R(\delta)$ in the other country. Thus, industries simultaneously react to the change in the size of the industry in the other country, due to the inter–industry movement of workers.

Proposition 3.4 (Symmetric interdependent strategies)**.** *Under and Condition 2.1, 2.2 and 3.1, if at $t = 0$ countries are in the Cournot equilibrium, and at $t > 0$ workers seek for a new job according to Assumption 3.1; and, simultaneously, each industry $z \in I_R(\delta)$ reacts to these movements by deciding the amount of labor to be hired (or fired), given the amount of labor hired (or fired) by the same industry in the other country, it is impossible to find a relative price of labor $\omega(t) > 0$ for any $t > 0$, and non zero movement of labor.*

Proof 3.4. *The labor demand at $t > 0$ can be expressed as a function of those at the inicial time 0, i.e. $\ell^c(z,t) = \ell^c(z,0) + d\ell^c(z,t)$. Given the result found in Proposition 2.2, the labor demands satisfy $\omega(0)\ell^1(z,0) + d\ell^2(z,t) = \omega(t)(\ell^1(z,0) + d\ell^1(z,t))$ for all $t \geq 0$. Arranging terms, a necessary condition for the symmetric equilibrium for any c and period $t \geq 0$ is*

$$\ell^1(z,0)\left(\omega(0) - \omega(t)\right) = \omega(t)d\ell^1(z,t) - d\ell^2(z,t) \tag{12}$$

Let assume that $d\ell^1(z,t) > 0$ workers decide to move between industries z_0 and z_1. Proposition 3.2 shows that the direction of the movement is $z_0 < z_1$ in Country 1, and $z_0 > z_1$ in Country 2. Then, $d\ell^1(z_0,t) > 0$ and $d\ell^2(z_0,t) < 0$ and, $d\ell^1(z_1,t) < 0$ and $d\ell^2(z_1,t) > 0$. From Equation (12),

$$\ell^1(z_0,0)\left(\omega(0) - \omega(t)\right) = \omega(t)d\ell^1(z_0,t) - d\ell^2(z_0,t) \geq 0 \tag{13}$$

$$\ell^1(z_1,0)\left(\omega(0) - \omega(t)\right) = \omega(t)d\ell^1(z_1,t) - d\ell^2(z_1,t) \leq 0 \tag{14}$$

The equations (13) and (14) hold simultaneously if and only if $(\omega(0) - \omega(t)) = 0$, since $\ell^c(z,0) > 0$ and $z = z_0, z_1$. Then, $\omega(t)d\ell^1(z,t) = d\ell^2(z,t)$ and, for any $\omega(t) > 0$ it satisfies that $d\ell^1(z,t) = 0$, since $d\ell^1(z,t)$ and $d\ell^2(z,t)$ have opposite sign for any non zero movement of labor ■

The Proposition 3.4 can be proved intuitively by noticing that the best strategy under Cournot rules is the Cournot solution. Consequently, the symmetric inter–industry movement of labor does not lead economies from the Cournot Equilibrium to the Competitive Equilibrium, relative price $\omega(t) = L^2/L^1$ and the perfectly competitive price $\omega(t) = B(z, L^2/L^1)$ coincides, which occurs if $\int_0^{\bar{z}} \alpha(z)dz = 0.5$.

3.2 Asymmetric movement

Let assume that Condition 3.1 applies only to Country 1, and workers in Country 2 cannot freely seek for a new job[2]. In such an asymmetric case, industries in Country 2 react to the change in the size of the $z \in I_R(\delta)$ industries in Country 1. This strategy is similar to the Stackelberg strategy, where the Country 1 (with free movement of labor) is the leader and the Country 2 is the follower.

Given that Country 1 is the leader, the decision related to the size of the $z \in I_R(\delta)$ industries is taken independently from decision in Country 2: workers move until the gains from it is positive. In Country 2, workers cannot freely move from an industry to another, and industries react to the Country 1 strategy, and Equation (3) holds.

Therefore, for the $z \in I_R(\delta)$ industries in Country 1, the demand of labor is $\ell^c(z,t) = \ell^c(z,0) + d\ell^c(z,t)$; and, in Country 2, the demand of labor satisfies $R^2(z,t;x^1)$ given by Equation (3). Otherwise, for all $z \in I_S(\delta)$ industries, there are no reasons for changing the supply strategy and $x^c(z,t) = R^c(z,t;x^{c\prime})$ holds in both countries.

Proposition 3.5. *Under Condition 2.1 and 2.2, if at $t = 0$ countries are in the Cournot equilibrium, and at $t > 0$ workers of the $z \in I_R(\delta)$ in Country 1 seek for a new job according to Assumption 3.1; and, each industry in Country 2 reacts to these movements by deciding the amount of labor to be hired (or fired), then $\omega(t) \geq L^2/L^1$ for all $t \geq 0$.*

Proof 3.5. *Since the labor market is in equilibrium —see Equation (9)—, using the result of Proposition 2.2, for all $z \in I_S(\delta)$ the labor demands satisfy $\ell^2(z,t) = \omega(t)\ell^1(z,t)$, then the following relation holds:*

$$\frac{L^2 - \int_{I_R(\delta)} R^2(z,t;x^1)a^{c\prime}(z)dz}{L^1 - \int_{I_R(\delta)} \ell^1(z,0)dz} = \omega(t)\frac{\int_{I_S(\delta)} \ell^1(z,t)dz}{\int_{I_S(\delta)} \ell^1(z,t)dz} = \omega(t) \tag{15}$$

Since all workers find a new job or do not move, then $\int_{I_R(\delta)} d\ell^1(z,t)dz = 0$. Thus, the denominator, $\int_{I_R(\delta)} \ell^1(z,0)dz$, is independent from the inter–industry movements.

Under Assumption 3.1 the workers leave the $z \in [1-\delta, 1]$ industries without comparative advantage and seek for new jobs in the $z \in [0, \delta]$ industries with comparative advantages —by Condition 2.1 the function $a(z)$ is an increasing function. Then, $x^1(z,t)$ increases if $z \in [0,\delta]$ industries, and it decreases if $z \in [1-\delta, 1]$. The Proposition 2.3 shows that $R^2(z,t;x^1)$ is non–increasing in $z \in [0,\delta]$ and non–decreasing in $z \in [1-\delta, 1]$. Then, $\ell^2(z,t) \leq \ell^2(z,0)$ for all $z \in I_R(\delta)$, and $\omega(t) \geq \omega(0)$ ■

The importance of Proposition 3.5 lies in taking into account that the Cournot relative price $\omega(t) = L^2/L^1$ and the perfectly competitive price $\omega(t) = B(z, L^2/L^1)$ coincide if $\int_0^{\bar{z}} \alpha(z) = 0.5$. Then, in such a case, the asymmetric inter–movement of labor takes the relative price of labor away from the competitive equilibrium price.

[2]The former Ecuadorian Labor Regulation, in force until 2014, punishes workers if they change jobs in the short–term (Código del Trabajo, artículo 181).

Corolary 3.2. *The movement of labor does not guarantee the convergence to the competitive equilibrium.*

4 Conclusions

This paper describes and analyzes the Cournot–Ricardo equilibrium under different conditions of inter–industry movement of labor. The conditions of labor market arise as a key factor in the determination of the properties of the perfectly competitive and monopolistic equilibrium. On the one hand, the inter–industry movement of workers leads economies to reduce the size of the industries without competitive advantage. Then, the freedom to draw up contracts guarantees the efficiency in production. Also, since workers have incentives to move, the Cournot–Ricardo model is not stable in a multisectorial model, excepting in the degenerate symmetric independent strategy case. Furthermore, we prove that the Cournot–Ricardo equilibrium does not lead economies to Ricardo–Mill model under freedom to draw up contracts.

However, the most important results are those related to the conditions of labor market. The conditions of labor market are esencial to determine the properties of the equilibrium in international trade. International firms and governments agree on consider labor conditions as crucial to determine the international competitiveness of an economy. Despite it, international economics seems to give a small importance to this matter. Finally, this paper shows that inter–industry movement of labor contributes to increase the degree of international competitiveness of countries, if per–worker payoffs depend on profits.

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