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The Effect of Taxation, Specialization, and Entrepreneurial Activities on International Trading

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Abstract

In this chapter, a generalization of the Ricardian model of international trading is presented. Unlike the original Ricardian analysis, the presented model takes into account the producers entrepreneurial activities, their specialization factor (the improvement factor in production due to specialization) and the countries taxes (tariffs). The main result of this model is that for a given entrepreneurial activity culture and a given specialization factor, there exists a critical taxation level, above which specialization and all entrepreneurial activities are suppressed and international commerce is ceased. The transition from a working international market to a trade-less one is an abrupt one and resembles a phase transition.

Keywords: entrepreneurship, international trading, specialization, unstable markets, entrepreneurial behavior, entrepreneur, iterative economic processes, Austrian school of economic

1. Introduction

One of the successes of the classical economics revolution was to rebut the mercantilist tradition that holds the premises that trading can be harmful for the trading countries. The success was not merely an academic one; as a result of this revolution, Britain, Europe and eventually the whole world experienced a great economic boom.

The revolution was based on three important realizations:

1. The market does not prefer specialization due to the differences in the inborn merits of humans. Specialization itself makes the market much more efficient. Even if initially people have the same general merits, they can still specialize and optimize the market.

2. The market is not a zero sum game. Both sides (countries), in any free transaction, buyers and sellers, benefit from trading.

3. Similarly, trading improves the condition of (international) producers, regardless of the efficiency differences between them.

Despite the fact that these realizations were initial ingredients in the classical revolution, the classical economists themselves did not integrate them in a single theory. While Smith talked only on the first and second realizations [1], Ricardo in the law of comparative advantage disregards the effect of specialization and focused on the third realization [2].

It is a common mistake to assume that Ricardo's law of comparative advantage does take specialization into account; however, it does not. It assumes that the producer's efficiency is independent of his specialization level [2–6].

During the marginalist revolution [7] in the 1870s, the world of economics experienced another split of visions: the majority of the economics community adopted the Marshallian-Walrasian tradition [8, 9], which based their studies on equilibrium analysis. A minority of the economists' community, which was known as the Austrian School [10–12], based their analysis on method-ological individualism, that is, they based their approach on the acting entrepreneur [13–15].

This approach was alien to the main stream, where the Marshallian-Walrasian tradition was rooted, especially after the work of Knight [16], which based the market on perfect knowledge. In a perfect knowledge market, there is no room for entrepreneurial activity.

Uncertainty is the playing ground in which the entrepreneur acts. Both schools recognize the fact that the market tend to an equilibrium state, but the realization is different. Perfect knowledge cannot exist in a disequilibrium market. It is much more difficult to explain the equilibria existence in the presence of perpetual entrepreneurial activities. The Austrian econ-omists explained that the entrepreneurs are not a disruptive element, but rather a stabilizing one, since the entrepreneur recognizes any deviation from equilibrium as an entrepreneurial opportunity. Consequently, his entrepreneurial act stabilizes the market and helps in keeping it at a semi-equilibrium state.

The main problem is that from the Austrian's writing, it seems as if the entrepreneur has some special merits [13–15], which helps him recognize the discrepancy in the market, which he can mitigate with his entrepreneurial activity. However, since it was not clear what this merits are, they never demonstrate it.

In [17], it was demonstrated that entrepreneurial activity can be totally random. No insight is required for a successful entrepreneurial act. In fact, the profit and loss mechanism along with some memory of past transaction is sufficient to navigate the entrepreneurial activity in the right direction to mitigate the deviations from equilibrium.

International trade requires specialization, and specialization is an entrepreneurial activity. The producer risks himself in specializing. While specializing, the producer compromises, for he has to change his production point, at least temporarily, to a worse one. His analysis teaches him that there is a good chance that eventually, after trading, his condition will be better; however, by no means, it is a simple decision to specialize. It is an entrepreneurial decision.

Taxes and regulations suppress entrepreneurial activity, but they operate in a different manner. Regulations prohibit some activities, while taxes reduce the motivation to make them. Therefore, trade, international and domestic, requires entrepreneurial activity and specialization, while taxes suppress the three.

There is a delicate connection between these components. For example, when entrepreneurial activities increase (either by educational activities or regulations' reductions), specialization and trading are encouraged despite the suppressive effect of some taxes.

Any theory of international trading that does not include entrepreneurial and specialization ([3]) along with taxes cannot be regarded as a complete theory. In this chapter, we propose a model, which integrate these components into a single model, which yields simple relations.

2. The effect of taxation

When two traders interact and exchange a certain good, their status is presented initially as a point in the commodities space. The exchange itself is presented by arrows, which oriented toward the final states (final points in the commodities space—see **Figure 1**). When there are no taxes, then the two arrows are identical in terms of length and slope.

However, when taxes are applied, then the head of the arrows is drawn toward the origin. It does not matter whether the taxes are collected in terms of commodity A or commodity B. The buyer 'sees' a higher price, while the seller 'sees' a lower one.

In **Figure 1**, the collected taxes are 20% of the exchanging commodities. In the figure, it is assumed that both buyers and sellers pay the same tax level.

In the Marshallian-Walrasian tradition, the price of commodities is determined by the intersection of the demand and supply curves [18]. This is a stationary equilibrium scenario.
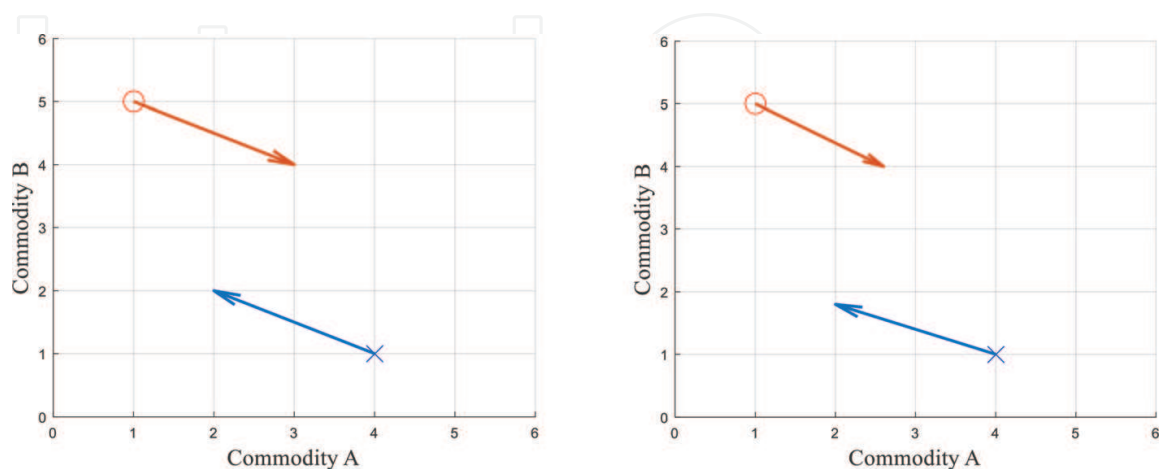

Figure 1. The 'x' and 'o' represent the two traders' possession before the trading transaction. The arrows represent the transaction itself. On the left, there are no taxes, and therefore the arrows are parallel, while on the right, due to taxes, the arrows are tilted toward the origin.

In general, the curves are unknown and can have an arbitrary shape (see, e.g. [19]); however, at the vicinity of the intersection, they can be approximated by a linear curve, that is, the demand curve (at the vicinity of the intersection) can be written as

$$D(p) = D - pd \tag{1}$$

while the supply curve can be written as

$$S(p) = S - ps, \tag{2}$$

where D, S, d and s are independent of the price p.

When taxes are applied, the price increases by a factor, which for convenience matters will be written as an exponent, e^t (which is equivalent to a tax of $100t\%$), that is, the demand curve decreases faster

$$D(p) = D - pe^t d. \tag{3}$$

Similarly, in the supply curve, the price decreases by e^{-t} (again, it is assumed that the taxes are equal for buying and selling), that is

$$S(p) = S - pe^{-t}s. \tag{4}$$

The intersection occurs when

$$D(p^*) = S(p^*) = \sqrt{DS} \frac{\sqrt{\frac{Ds}{Sd}}e^{-t} + \sqrt{\frac{Sd}{Ds}}e^t}{\sqrt{\frac{S}{d}}e^{-t} + \sqrt{\frac{d}{s}}e^t} = \sqrt{DS} \frac{\cosh(\alpha + t - \theta)}{\cosh(\alpha + t)} \tag{5}$$

where $\sqrt{\frac{D}{S}} \equiv \exp(\theta)$, $\sqrt{\frac{d}{s}} \equiv \exp(\alpha)$, at the price level

$$p^* = \sqrt{\frac{DS}{ds}} \frac{\sinh(\theta)}{\cosh(\alpha + t)}. \tag{6}$$

Therefore, the market price decreases, because taxes reduce the attractiveness of the commodity, while the consumer price increases to

$$p^* e^\tau = \sqrt{\frac{DS}{ds}} \frac{\sinh(\theta)\exp(t)}{\cosh(\alpha + t)}. \tag{7}$$

Clearly, trading is suppressed since cosh is a convex function, the denominator of Eq. (5) increases faster than the numerator. That is, Eq. (5) decreases when taxation increases.

However, even analyses, which consider taxation, still lack two important ingredients: specializations and entrepreneurship.

Following [6, 17], assume that the *production possibility frontier*s (PPFs) of two producers are

$$\frac{a_1}{A_1} + \frac{b_1}{B_1} \leq 1 \tag{8}$$

and

$$\frac{a_2}{A_2} + \frac{b_2}{B_2} \leq 1 \tag{9}$$

respectively. That is, the maximum numbers of units of commodities A and B that the first producer can produce are A_1 and B_1, respectively, and the production of the second one is bounded by A_2 and B_2, respectively, while a_1 and b_1 are the number of units the first producer chooses to produce, and similarly, a_2 and b_2 are the number of units the second one produces.

In this case, trading occurs provided the price $p \equiv \Delta A / \Delta B$, which is the ratio between exchanged commodities ΔA units of A for ΔB units of B, obeys

$$\frac{A_2}{B_2} < p < \frac{A_1}{B_1}. \tag{10}$$

However, if taxes are introduced, the condition for trading is less flexible

$$\frac{A_2}{B_2} < p\exp(-t) < p\exp(t) < \frac{A_1}{B_1} \text{ or}$$

$$\frac{A_2}{B_2}\exp(t) < p < \frac{A_1}{B_1}\exp(-t). \tag{11}$$

Therefore, trading is possible provided the tax level is lower than

$$t < \ln\left(\sqrt{\frac{A_1}{B_1}\frac{B_2}{A_2}}\right) \tag{12}$$

However, this analysis ignores, again, specialization.

3. The effect of specialization

In case the producers can specialize, the PPF becomes a convex curve. Therefore, if a manufacture specializes by doubling the time he invests in the production of a certain product, the resultant production increases by a factor, which is *larger* than 2.

Following [6, 17], we choose the following PPF, which takes specialization into account

$$\left(\frac{a}{A}\right)^\alpha + \left(\frac{b}{B}\right)^\beta = 1 \tag{13}$$

The smaller the exponents α, β the higher is the level of specialization.

Hereinafter, to simplify the analysis, we take that the specialization level in both commodities is the same, that is, $\alpha = \beta$. Therefore, we focus on a PPF of the form

$$\left(\frac{a}{A}\right)^\beta + \left(\frac{b}{B}\right)^\beta = 1, \tag{14}$$

in which case the relation between the specialization factor F and the exponent $\alpha = \beta$ is simply [6].

$$F = 2^{1/\beta - 1}, \tag{15}$$

which means that the ratio between the production productivities in the case of full specialization (free trading) and no specialization (no trading) is $F = 2^{1/\beta - 1}$ [6].

Since the units, by which the commodities are measured, are arbitrary, then without the loss of generality, we can replace the parameters to the dimensionless coordinates $\xi \equiv a/A$ and $\eta \equiv b/B$. Therefore, Eq. (14) reads

$$\xi^\beta + \eta^\beta = 1. \tag{16}$$

Furthermore, it is convenient to change the coordinates into radial ones, that is

$$\xi^2 + \eta^2 = r^2, \tag{17}$$

$$\xi = r\cos\varphi, \text{ and} \tag{18}$$

$$\eta = r\sin\varphi. \tag{19}$$

Then, instead of the Cartesian relation $\eta = \left(1 - \xi^\beta\right)^{1/\beta}$, a radial one emerges

$$r(\varphi) = \frac{1}{\left(\sin^\beta\varphi + \cos^\beta\varphi\right)^{1/\beta}}, \tag{20}$$

and due to the symmetry of the problem, it is more convenient to use the deviation from the 45° angle, that is, we take the angle $\delta = \varphi - \pi/4$, in which case

$$r(\delta) = \frac{1}{\left(\sin^\beta(\pi/4 + \delta) + \cos^\beta(\pi/4 + \delta)\right)^{1/\beta}} = \frac{\sqrt{2}}{\left((\cos\delta + \sin\delta)^\beta + (\cos\delta - \sin\delta)^\beta\right)^{1/\beta}} \tag{21}$$

For small angles, Eq. (21) can be approximated by

$$r(\delta) \cong r_0 + \left(1 - \frac{\beta}{2}\right) r_0 \delta^2 \tag{22}$$

where

$$r_0 \equiv r(\delta = 0) = 2^{1/2 - 1/\beta} \tag{23}$$

is the distance to the origin.

Equations (21) and (22) allow one to evaluate the specialization r as a function of the entrepreneurial activity δ, because δ is the deviation from the (pre-trade) optimal point.

Therefore, if any single producer/entrepreneur can decide in changing his working point from $(r_0, \delta = 0)$ to $(r(\pm\delta), \pm\delta)$, then the producers' population splits into two sub-groups: one at $(r(\delta), +\delta)$ and the other at $(r(\delta), -\delta)$.

These two populations start trading with a price, which in the $\xi - \eta$ space is equal to 1 (which is B/A in the $a - b$ space). Therefore, after trading they both converge to the point $(r(\delta)\cos(\delta), 0)$, which is more favorable point in the preference ranking of the producers (since this point is perpendicular to the PPF) (**Figure 2**).

When taxes are applied, the final point (after trading, AF) is closer to the origin (0,0), that is, $r_{AF}(\delta) < r(\delta)\cos(\delta) \cong r_0 \left[1 + \left(\frac{1-\beta}{2}\right)\delta^2\right]$. Clearly, when the taxes are high so that $r_{AF}(\delta) \leq r_0$, then the motivation for entrepreneurship, specialization, and trading vanishes.

This event occurs when the change in the arrows slope, which is the normalized change in the price Δp, is equal to
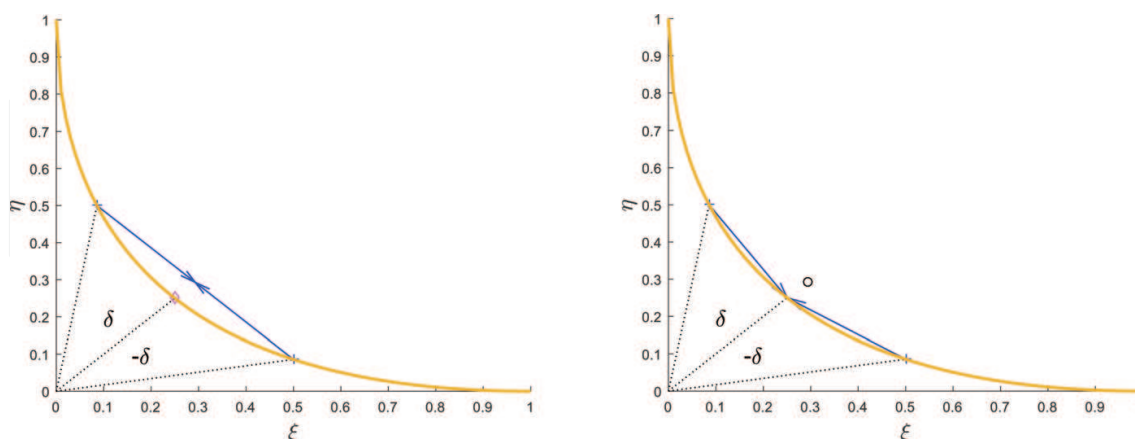

Figure 2. Trading in the presence of specialization and taxation. Without specialization, the production point is $\xi = \eta = 1/4$ (the diamond in the left figure). The curved line is the PPF. With specialization, the producers' production point splits into the two '+', while trading (represented by arrows) improves the status of both producers to the point represented by 'o' (in the right figure). Taxation tilts the arrows to a worse position, which can even eliminate the specialization beneficial effect (the right figure).

$$\Delta p = 2\frac{r(\delta)\cos\delta - r_0}{r(\delta)\sin\delta} \cong (1-\beta)\delta, \tag{24}$$

However, the normalized change in the price is exactly the tax level, that is, the tax level beyond which no trading is possible (t_c) is equal to

$$t_c \cong (1-\beta)\delta. \tag{25}$$

Eq. (25) is the main result of this chapter, for it integrates taxation (t) specialization (β) and entrepreneurship (δ) in a simple relation.

Now since (Eq. (15)) $\beta = \frac{1}{1+\log_2 F}$, then we can formulate an expression which relates the entrepreneurial parameter δ and the specialization factor F to the critical taxation level t_c:

$$t_c \cong \frac{\delta}{1 + 1/\log_2 F} \tag{26}$$

This equation can be rewritten to evaluate the critical specialization factor, which is required to initiate trading for a given level of entrepreneurship and taxation, namely

$$F_c = 2^{(\delta/t-1)^{-1}}. \tag{27}$$

This is the specialization factor required to overcome the suppression effect of the countries' tariffs, the graph of which is presented in **Figure 3**.

Since without specialization, the production frontier is $a/F + b/B = 1/F$, then δ can be easily replaced with a corresponding variation in the real commodity units Δa and Δb, namely

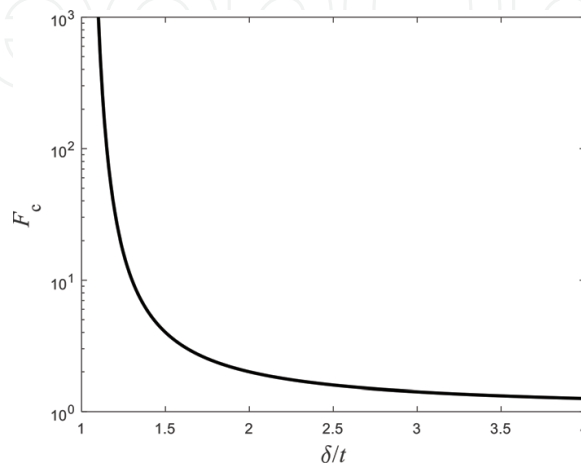$$\delta = -\sqrt{8}F\frac{\Delta a}{A} = \sqrt{8}F\frac{\Delta b}{A} \tag{28}$$

Figure 3. The dependence of the critical specialization factor as a function of the ratio between δ and the tax level t.

and therefore, the critical taxation can be written as a function of the real change in production, caused by the entrepreneurial decision, that is,

$$t_c \cong \frac{\sqrt{8}F|\Delta a/A|}{1 + 1/\log_2 F} = \frac{\sqrt{8}F|\Delta b/B|}{1 + 1/\log_2 F}. \tag{29}$$

4. Perpetual entrepreneurial activities

In real markets (international and domestic) where the traders are also producers, as was explained above and in [17], the producers take much risk when they decide on the amount of good to produce. In this case, a producer may find himself in a worse condition. Any change in his production habits is a temporary deterioration in his preference ranking.

Clearly, the only information he has on the other producers' preferences is the market price, which in our units is approximately $p = 1$.

Let us assume that all producers are identical; therefore, they all have the same production frontier, then the nth producers can be characterized by the Cartesian pair (ξ_n, η_n) or the radial pair (δ_n, r_n). Similarly, they all have the same preference ranking matrix $R(\xi, \eta)$. This two-parameter function (matrix in the discrete case) can be regarded as the utility function of the state (ξ, η); however, when the parameters (ξ, η) are discrete, then a ranking function is consistent with the Austrian school as well ([6, 20]). Therefore, we prefer to use the term 'preference ranking' matrix instead of 'utility' function.

Initially therefore, the point with the highest preference ranking is $\xi_n = \eta_n = r_0/\sqrt{2}$, that is,

$$R_n^{(0)} = R\left(r_0/\sqrt{2}, r_0/\sqrt{2}\right) = \max_{\eta < \eta[\xi_n]} R(\xi, \eta), \tag{30}$$

which is equivalent in radial coordinates to $r = r_0$ and $\delta = 0$ (for all n).

When trading begins, each one of the producers uses the current market price to evaluate future profits from possible production alternatives. This is a perpetual process [21], which consists of multiple iterations.

Let m represents the iteration number. Initially, $m = 0$.

In any iteration, the market price is first determined. Let the market price of the mth iteration be $p^{(m)}$.

Furthermore, it is assumed that the state of the nth producer at the mth iteration is characterized by the two parameters $\left(\delta_n^{(m)}, r_n^{(m)}\right)$, and therefore their state in the $(m + 1)$th iteration can be written

$$\delta_n^{(m+1)} = \delta_n^{(m)} + \Delta\delta_n^{(m)} \tag{31}$$

$$r_n^{(m+1)} = r\left(\delta_n^{(m+1)}\right) \tag{32}$$

where $r(x)$ is function (21), and $\Delta\delta_n^{(m)}$ are random variations that are subject to the constrains

$$-\frac{\pi}{4} \le \delta_n^{(m)} \le \frac{\pi}{4}. \tag{33}$$

These states can easily be transformed back to Cartesian coordinate by

$$\xi_n^{(m)} = r_n^{(m)} \cos\left[\delta_n^{(m)}\right]. \tag{34}$$

$$\eta_n^{(m)} = r_n^{(m)} \sin\left[\delta_n^{(m)}\right] \tag{35}$$

Now, all the possible states that are reachable by trading $\{\xi, \eta\}$ must obey

$$\eta - \eta_n^{(m+1)} \le -\tau p^{(m)}\left(\xi - \xi_n^{(m+1)}\right), \tag{36}$$

where $\tau = \exp(\mathrm{sgn}(\delta)t) = \begin{cases} \exp(t) & \delta > 0 \\ \exp(-t) & \delta < 0 \end{cases}$ is the taxation effect on the price level (note that it has the opposite effect on buyers and sellers).

If among all these points (which are reachable by trading), there is at least one point, whose preference ranking is larger than the previous iteration ranking $R\left(\xi_n^{(m)}, \eta_n^{(m)}\right)$, that is,

$$R\left(\xi_n^{(m)}, \eta_n^{(m)}\right) < \max_{\eta - \eta_n^{(m+1)} \le -\tau p^{(m)}\left(\xi - \xi_n^{(m+1)}\right)} R(\xi, \eta) \tag{37}$$

Then, $\left\{\xi_n^{(m+1)}, \eta_n^{(m+1)}\right\}$ (or equivalently $\left(\delta_n^{(m+1)}, r_n^{(m+1)}\right)$) is chosen as the next iteration production point, otherwise (if the ranking is lower than the previous one) then this trial point is rejected and the previous production point is kept.

Clearly, this process determines the production decisions, and it does not include the trading results. In principle, nothing assures the entrepreneurial producer that he will reach a higher ranking point. This is a risk that he takes.

5. Simulations

We simulate the market with N entrepreneurs, which their entrepreneurial activities in every iteration $\Delta\delta$ are randomly selected with a uniform distribution, namely their probability density satisfies

$$P(\Delta\delta = x) = \begin{cases} 1/\Phi & |x| < \Phi/2 \\ 0 & else \end{cases}. \tag{38}$$

All entrepreneurs have the same PPF with a specialization exponent of $\beta = 1/2$ (which is equivalent to a specialization factor of $F = 2$).

We begin with zero taxes and $N = 40{,}000$ entrepreneurs. These entrepreneurs can be distributed among different countries provided there are no tariffs.

In this case, the initial market is totally unstable, and in the very first trading iterations, the market splits into two distinct population sub-groups: one group produces more units of commodity B than units of commodity A (for which $\delta > 0$) and vice versa for the second group (for which $\delta < 0$). The problem is totally symmetric, and there are no drifts (unlike [17], where the drifts seem to be a simulation artefact).

In **Figure 4**, two histograms of the population as a function of the iterations number (the time) are presented. As can be seen, the population indeed splits into two population sub-groups.

Therefore, half of the iterations, on average, do not improve specialization, because they work in the wrong direction. The average improvement, among those that do contribute, is $\Phi/4$ (the average between zero and $\Phi/2$); therefore, the specialization angles increase linearly with the iteration number m:

$$\delta(m) = \begin{cases} \pm\Phi m/8 & \Phi m/8 < \pi/4 \\ \pm\pi/4 & else \end{cases} \tag{39}$$

where m stands for the iteration number and the upper/lower signs of '$\pm$' stand for the buyers/ sellers population group, respectively. These equations are presented in the left plot of **Figure 4** by the dashed lines for the simulation parameter $\Phi = 0.015 Rad$.

Similarly, we can clearly see the 'parabolic' rise in the specialization factor r (the right figure). The dashed curve corresponds to the function

$$r(m) = \begin{cases} \dfrac{1/\sqrt{2}}{\cos(\Phi m/8) + \sqrt{\cos(\Phi m/4)}} & \Phi m/8 < \pi/4 \\ 1 & else \end{cases} \tag{40}$$

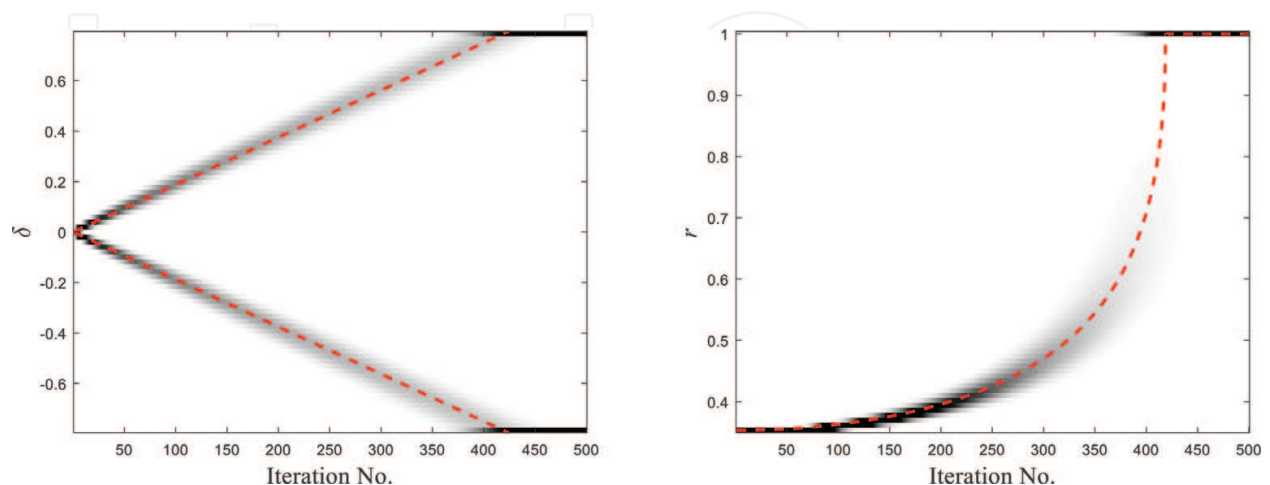which is a derivation of Eq. (21) for $\beta = 1/2$.

Figure 4. The population distribution as a function of the iteration number (temporal histogram). The darker the color, the higher is the number of producers. The instability is clearly shown as the population splits into two sub-groups of specialized producers-buyers and sellers. The dashed curves correspond to functions (39) and (40).

When transaction taxes are applied (i.e. tariffs in international trading), then the system can be quasi stable.

In the next simulation, the tax levels are varied. For every tax level, 500 iterations were applied on a market of $N = 400$ participants (which can represent 400 countries). The results are presented in **Figures 5** and **6**. The transition between the specialization domain (high r) and non-specialization domain (low r) is clearly seen. Below the critical taxation level, the market experiences a split, and full specialization is reached when the standard deviation of δ converges to $\sigma(\delta) \to \pi/4$, while the mean specialization parameter r converges to $\langle r \rangle \to 1$. However, when the taxes are higher than the critical level $t_c \cong \Phi/4$ (note that $\beta = 1/2$), specialization and trading are totally suppressed. The transition is extremely sharp and it resembles a phase transition.

When the simulation runs over many entrepreneurial parameter's value (Φ), a phase diagram appears (**Figure 7**). The gray levels represent the mean value $\langle r \rangle$ after 500 iterations. However,
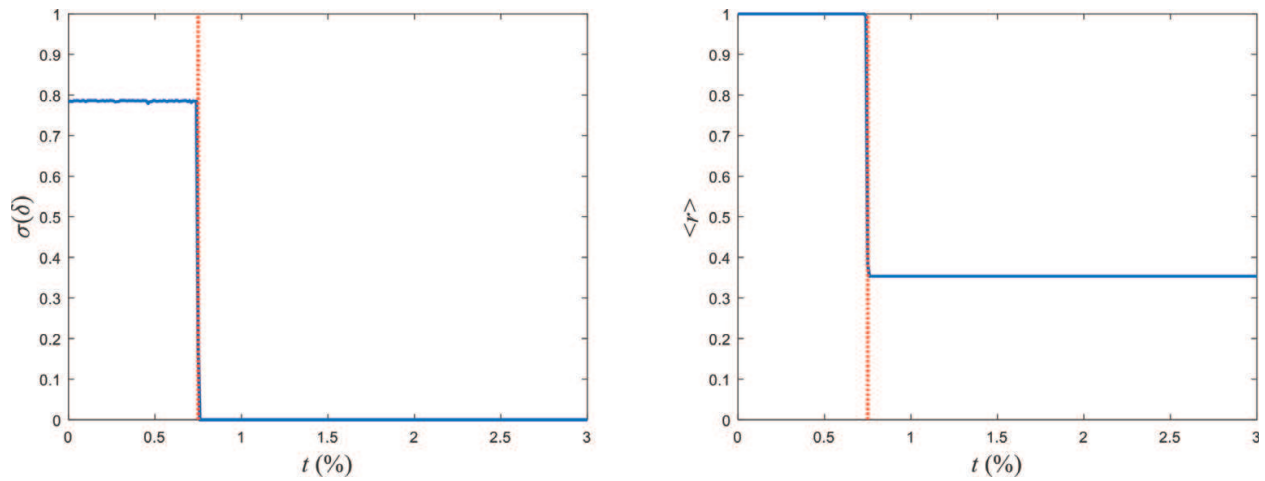

Figure 5. The impact of taxation on the standard deviation of δ, left figure, and the mean value of r, right figure (both are a measure of specialization) for the entrepreneurial parameter $\Phi = 0.03Rad$ after 500 iterations and $N = 400$ participants (entrepreneurs/countries/producers). The critical taxation level $t_c \cong (1-\beta)\Phi/2$ is presented by the horizontal dashed line.
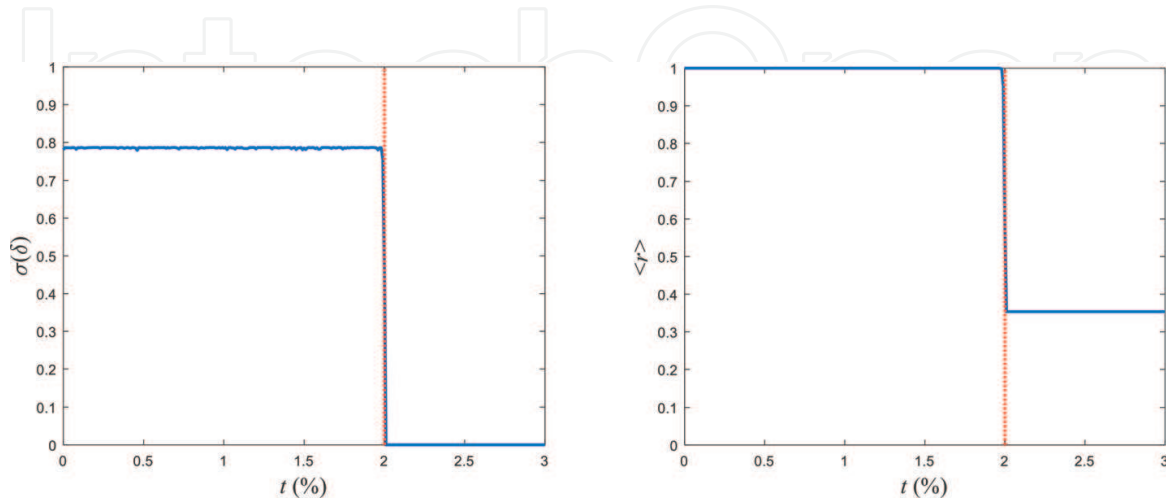

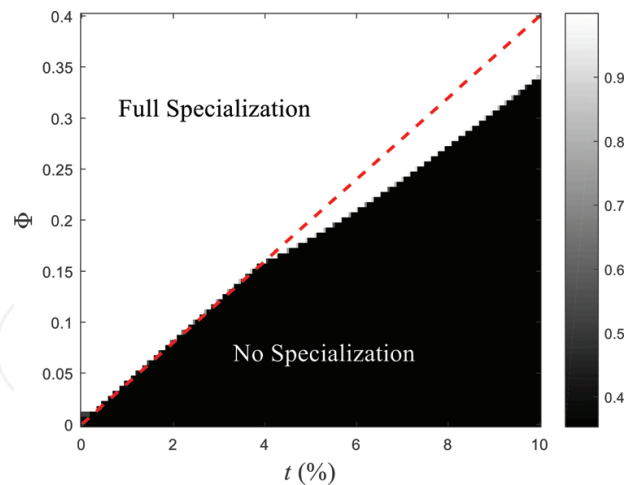**Figure 6.** Same as **Figure 5** but for $\Phi = 0.08Rad$.

Figure 7. A two-dimensional phase diagram. The diagram represents $\langle r \rangle$, which is a measure of market specialization, as a function of the entrepreneurial activity parameter Φ and the taxation level t. The darker the color, the lower is the value of $\langle r \rangle$. The phase transition is clearly seen. The dashed line corresponds to $t_c \cong (1 - \beta)\Phi/2$.

there are no gray levels, there are only black (no specialization and no trading) and white (full specialization and full trading). For low taxation level, the transition between the two 'phases' agrees with the theoretical line $t_c \cong (1 - \beta)\Phi/2$.

It should be stressed that in this chapter, it was assumed that the entrepreneurial activity is bounded by regulations. These regulations were manifested by the uniform distribution. In case the regulations are less binding, and the entrepreneurial activity is unbounded and is affected only by human merits, then the distribution may be replaced by a normal, that is, Gaussian, distribution, in which case the transition between phases depends on the measurement time and is clearly less sharp.

6. Summary

In this chapter, a generalization of the Ricardian model was presented. Unlike the original model, the presented one takes into account:

1. Entrepreneurial activities. The model regards the market as a perpetual process of entrepreneurial actions. The producers check random variations and choose the ones with the highest prospect of being profitable.

2. Specialization. The model takes into account the fact that specialization is not a linear process.

3. Taxes and tariffs. In the presence of taxes, the effective price that the buyer 'sees' is different from the one the seller 'sees'. This fact is also taken into account.

The main result of this model is that when the entrepreneurial activity is bounded by regulations (and can be approximated by random variables with a uniform distribution), a critical

taxation level appears, below which the market propagates toward full specialization, and the market clears by trading, while above this level, specialization is fully suppressed and no trading is possible. The transition between these two domains is extremely sharp and resembles a phase transition.

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