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SYMPOSIUM

Are the antiglobalists right? Gains-from-trade without a Walrasian auctioneer

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Abstract We show that the "fear" of globalisation can be rationalised by economic theory in the standard AD/AS equilibrium model, if we substitute the coordinational role of the Auctioneer by an implementation device based on learning (Guesnerie in Am Econ Rev 82, 1254–1278, 1992). When endowing producers with a learning ability to forecast market prices, individual profit-maximizing production decisions become interdependent in a strategic sense (strategic substitutes). Performing basic comparative statics exercises, we show that "competitiveness" matters in a precise sense: as foreign producers gain access to the home market, home producers' ability to forecast market prices is undermined, so being their ability to forecast the profit consequences of their production decisions. A standard open economy exercise shows that the efficiency gains triggered by increased competition have to be traded-off against higher uncertainty (a lower likelihood to coordinate upon the welfare enhancing free-trade equilibrium). We interpret it as a new rationale for the existence of barriers to trade targeting coordination, rather than protecting mere inefficient sectors or industries (political economy driven). Finally, we show that classical measures

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evaluating ex-ante the desirability of economic integration (net welfare gains) do not always advice free trade.

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1 Introduction

> "*…learning is the adjustment mechanism whereby the economy is steered to the new equilibrium after a structural change.* "(Evans and Honkapohja 2001, p.81).

It is nowadays well established that the potential benefits of trade liberalisation come from equalizing the prices of those commodities produced at different (real) costs across regions. Trade economists perceive borders as "historical" distortions to the efficient allocation of scarce ressources by the market, and therefore compare the associated welfare gains before and after trade liberalisation. At least since Grandmont and McFadden (1972) or Dixit and Norman (1980, 1986) published their works, we understand that in the context of the standard Arrow–Debreu general equilibrium paradigm, provided that adequate redistributional schemes operate inside each region, it is possible to compensate those who lose from trade and let everyone at least as well as they were in autarky. Confronted with such a prediction, the reluctance to remove existing trade barriers is perceived by most of the scientific trade community as a paradox.[1] Among the possible solutions to the paradox, political economy driven governments, oligopolistic market structures, missing markets, imperfect or missing supra-national institutions or inadequacy of national redistribution schemes are often cited.[2] Here we propose a new one: the structural changes that trade liberalisation triggers exacerbate the ex-ante uncertainty that producers perceive, rendering them reluctant to accept the free-trade policy ex-ante. An immediate corollary is that trade barriers, in either the form of a quota or a tariff, will be preferred because they reduce the uncertainty triggered by an abrupt transition to free trade.

A recent strand of the trade literature examines intra-industry effects of international trade in a general equilibrium setup with firm-heterogeneity [see Bernard et al. (2003) or Melitz (2003)]. There, trade induces a labor reallocation from least to most productive plants, inducing endogenous entry and exit from the industry relative to autarky. Although in the simple partial equilibrium model[3] upon which we hinge we cannot consider this issue, we still capture the profit redistribution channel across regions

[1] Among the myriad of works, see Deardorff (2002), Krugman (1987) or Rodrik (1997).

[2] See Bourguignon et al. (2002) for a synthesis.

[3] From a classical normative point of view, the partial equilibrium framework is a particular case of a general equilibrium economy for which Dixit and Norman (1980) showed the existence of ex-post transfers that leave everybody better off. However, the effective implementation of these transfers, from an eductive viewpoint, remains an open question because its existence modifies the rules of the game, and will therefore alter the strategic behaviour of producers.

triggered by an increase in competition, absent from these models. As a by-product, we will provide a rationale for the controversial notion of "competitiveness".

The work proceeds as follows: In Sect. 2 we summarize the main results of the paper implied by the "eductive" learning approach. In Sect. 3, we describe the linear version of Guesnerie's (1992) model, and his main results relevant to our work. The reader familiar with his work can directly start in Sect. 4, where we study the effect of signing a free trade agreement between regions characterized by linear aggregate demand and supply schedules ("linear class"). In Sect. 5, we compare the expectational coordination criterion to a traditional ex-ante welfare evaluation of economic integration, to show that a trade-off exists between both. Finally, Sect. 6 concludes.[4]

2 Implications of "eductive" learning for free trade

The only non-standard assumption upon which we rely here is that no Walrasian Auctioneer will lie behind the price determination process. Rather, we will take a step back, and adopt a decentralized foundation of the competitive equilibrium developed by Guesnerie (1992, 2002). There, infinitesimally small, perfectly rational and completely informed heterogenous producers realize that the profit consequences of their individual production decisions depend on an aggregate of the decisions taken by the rest, confining them to a strategic framework where they need to form expectations on others' actions (and expectations).[5] When producers are able to individually forecast the actual market price, coordinating on a single course of action that confirms the forecast ("expectational coordination"), the standard competitive equilibrium price as if determined by a Walrasian Auctioneer prevails. That insight effectively transforms the "static" Walrasian framework into a "dynamic" competitive one, where the corresponding equilibrium notion is that of a perfect foresight equilibrium (PFE) in prices, actions and expectations. Its effective implementation is then guaranteed by the convergence of a learning process ("eductive" learning), upon which we rely to compare equilibria before and after the policy change.

There, convergence is characterized by a condition on the elasticities of demand and supply isomorphic to the condition under which convergence of "coweb tatônnement" obtains, i.e. when a "high demand elasticity" and a "low supply elasticity" are observed. This condition has a natural interpretation in open economy. When the producers of a particular region gain access to new markets *ceteris paribus* (exporting), the new demand function that home producers serve is relatively "more sensible to price changes" than before because the relative scarcity of the home produced commodity

[4] *Remark* Throughout the work, the words "local" versus "global" are used in their standard mathematical meaning, and are not to be confused with "regional" versus "free trade", "open economy" or "economic integration" meanings in economics. Most international trade exercises involve comparative statics analysis that are "global" mathematically speaking, as they require the comparison of equilibria that need not be "topologically close".

[5] This basic framework encompasses the reduced form of standard macroeconomic models in their non-noisy versions, like the Lucas aggregate supply model or a simple version of the Cagan inflation model. See Evans and Honkapohja (2001) for additional details. As well, it can be seen as the competitive limit model of a large Cournot game, where producers are "small" with respect to the market size. On the latter, see Novshek (1980) or Vives (1999) for further details.

has increased. Effectively, given home and foreign demand, now the price "depends less" on the quantities produced by home producers, relaxing the "strategic component" in home producers' forecasts, tempering producers' strategic uncertainty. Exporting then favours expectational coordination, because producers' forecasts of the market price become more reliable, and so will their expected profits. This refers to the "stabilizing" role of a high demand elasticity. However, opening the home market to foreign producers *ceteris paribus,* will have the opposite effect. As home demand is now served by both home and foreign producers, the relative abundance of the commodity increases, and so does the "sensibility of supply to price changes". Since given demand, the final price depends on the quantities produced now by both home and foreign producers, producers' decisions become more interdependent in a truly strategical sense. Therefore, home import penetration undermines the ability of home producers to forecast the price that will prevail in the market, and therefore the associated profits relative to autarky ("competitiveness" matters). This refers to the "destabilizing role of a high supply elasticity". Free trade, by combining both, will have an ambiguous net effect on the reliability of producers' forecasts, and thus on coordination.

The main result of this paper relies on the adverse impact of free trade on the ability of producers to forecast the equilibrium price[6] when *differences across regions in the valuation of the produced commodity* or *in price-varying supply and demand elasticities prevail*. Through enhanced competition, free trade creates a redistributional conflict between producers across regions, leading some to expect higher prices and others lower ones relative to autarky (direct effect). Under the aforementioned conditions, producers operating with diferent costs respond to the policy induced expected price changes in proportion, thereby introducing additional heterogeneity in the magnitude of the responses to the initial redistributional conflict (indirect effect). Overall, coupling both the direct and the indirect effect, the reliability of producers' free trade equilibrium price forecasts is unambiguously undermined, exacerbating the uncertainty producers were confronted with in autarky.[7] Intuitively, producers need to forecast both the equilibrium price that will prevail after the policy change (direct effect) and the impact of others' reactions on others' equilibrium price forecasts (indirect effect). The impact of others' reactions on others' forecasts will depend on the magnitude of their individual responses to the anticipated changes of the free trade equilibrium price. Then *because of* free trade, spurious price volatility and multiple equilibria may arise. Summarizing: since producers's (real) costs differ across regions, standard efficiency gains justify a free trade policy. *But* since the plausibility

[6] Examples of the literature on firm dynamics with heterogeneous firms, such as Hopenhayn (1992) or Melitz (2003), assume that firms are uncertain about their productivity and face sunk entry costs, so that they have to take forward looking decisions anticipating future probabilities of exit. Both assume that firms correctly anticipate the stationary equilibrium productivity probability distribution. In this work we study the conditions under which producers can actually learn the equilibrium probability distribution.

[7] In the class of models considered, Guesnerie (2002) convincingly argues that although strategic substitutabilities (or complementarities) determine the sign of agents' reactions to expectations, what is instrumental for expectational coordination is the magnitude of these reactions. As expectational coordination is governed by a condition on first derivatives, the magnitude of the reactions to the policy change is measured by changes in first derivatives.

of coordination upon the welfare enhancing free-trade equilibrium price is also undermined, embracing free-trade from an ex-ante viewpoint needs not follow.[8] Notice that the main argument of this work encompasses rather than excludes the political economy motiviation (i.e. the ex-ante certainty of losing because of free-trade), and may thus provide a microfundation for it.

Finally we compare the expectational coordination criterion with a traditional ex-ante gains-from-trade criterion.[9] In the class of models considered, the net welfare gain from free trade increases the more heterogeneous the signing regions are, i.e. given identical demands across regions, the gains are larger the larger the differences in average production costs. But the larger the differences in the latter, the more heterogeneous the supply responses will be to the free trade policy induced price change, and the lower the probability of expectational coordination.

3 Preliminaries

If one is to recognize that economics is not a natural science because economic agents make forecasts that influence the time path of the system, it becomes crucial to understand how do economic agents form expectations. Faced with this problem, the modern macroeconomics literature has focused on how do economic agents "learn". A strand of the "learning" literature views economic agents as statisticians who use sophisticated forecasting techniques to estimate the parameters of the law of motion governing the economic system, and on the same time taking into account that the use of these techniques shapes the motion itself. Stated otherwise, available information on the evolution of the economic system is at best incomplete even to the most sophisticated economic agent.[10] The question is then whether the estimated motion would (at least) asymptotically approximate the motion consistent with agents forming a rational expectation. This is called the "adaptive approach to learning" (or evolutive learning) and has a long lasting tradition.

A different strand of the literature upon which we hinge here, is the "eductive approach to learning". This second modern approach admits that agents are rational and know the whole structure of the model describing the evolution of the system.

[8] Notice that there is also a sense in which the eductive viewpoint offers new hope in overcoming some of the old arguments for coordination at the international level, as it provides conditions favouring coordination in the absence of explicit coordinating institutions.

[9] The reason we adopt an ex-ante viewpoint (before effective integration takes place) is that the appropriate criterion would necessitate computing producers' welfare when the set of equilibria is an interval of the real line, which is beyond the scope of the present work. Allen et al. (2002) address this problem in generic competitive exchange economies with countably many competitive equilibria. Here we will have uncountably many.

[10] Manski (2004) presents two serious reasons in support of the incomplete information workhorse assumption: empirical data captures the result of choices, and not the expectations of decision makers when confronted with choices. Second, one cannot expect to recover objective evidence on expectations because of the selection bias (logical unobservability of counterfactual outcomes). By these reasons, he supports data collection on expectations. Recent work by Evans and Honkapohja (2001) along the lines of adaptive learning, solves the design of optimal monetary policies when observed data on private agents' expectations are incorporated in the policy maker's optimal monetary rule.

Nevertheless, agents form expectations that need not coincide: Bernheim (1984) and Pierce (1984) show that rationality of the players and complete information of the game being played, even when they are "common knowledge" (CK), do not imply the Nash equilibrium outcome but a different solution concept called a "rationalizable equilibrium".[11] Guesnerie (1992) applies the notion of rationalizability to a version of the standard Muthian model, to show that CK of rationality and of the model are not enough for them to always coordinate their expectations on the unique Rational Expectations Equilibrium (REE) solution defined by Muth (1961). In this sense, since the definition of a REE imposes expectational coordination, the eductive approach looks for structural conditions under which isolated independent agents' subjective expectations end up coordinating upon a REE.

In this section we present Guesnerie's (1992) version of Muth's model and his main results relevant to our work. The equilibrium concept will be a "Rationalizable Expectations Equilibrium", as defined in Guesnerie (1992, 2002).

3.1 The model and the equilibrium concept

The model describes a two-period partial-competitive equilibrium of an agricultural commodity economy. A continuum of profit maximizing risk-neutral farmers $f \in [0, 1]$ with a differentiable and strictly convex cost function $C(q, f)$ must decide the quantity q to be produced a period in advance on selling, given a predictable demand $D(p)$, assumed to be downward sloping $D'(p) < 0$ and resulting from the aggregation of a continuum of identical consumers indexed by c, $D(p) = \int D(p, c)\mathrm{d}c$. The effective equilibrium price is unknown because it depends on what other farmers will decide to produce. Therefore, the supply of each producer will also depend on the probability distribution of the price, denoted $\mathrm{d}\mu(p)$.[12] Since farmers are risk neutral, their production decisions will only depend on the expectation of the price $Ep = \int p\mathrm{d}\mu(p)$:

$$S[p, \mathrm{d}\mu(p), f] = \left(\partial_q C_f\right)^{-1}[p, \mathrm{d}\mu(p)] \in \arg\max_q \int [pq - C(q, f)]\,\mathrm{d}\mu(p).$$

Putting the Lebesgue measure on [0, 1], aggregate supply will be given by:

$$S[p, \mathrm{d}\mu(p)] = \int S[p, \mathrm{d}\mu(p), f]\mathrm{d}f$$

Under the above assumptions, the unique REE price $\overline{p}$ of this model will be given by the equality of aggregate supply and aggregate demand in expectation, computed

[11] Tan and da Costa Werlang (1988) transform a non-cooperative game into a Bayesian decision problem where the uncertainty faced by a given agent is formed by the actions, priors over actions, priors over priors over actions, etc. of the other agents. They show that common knowledge of the actual strategies to be played is only necessary for players to play Nash strategies.

[12] Strictly speaking, the probability distribution differs across farmers, i.e. $\mathrm{d}\mu(p, f)$.

using $d\mu(\overline{p}, f) = d\mu(\overline{p}), \forall f$ (i.e. farmers form rational expectations):

$$\overline{p} = D^{-1}(S[\overline{p}, d\mu(\overline{p})])$$

Since there is no noise, the REE price $\overline{p}$ is called a PFE. Following Evans' (1985) assertion according to which a REE is in the class of Nash equilibria in actions *and beliefs* (NE), $\overline{p}$ is also the unique NE.[13]

Building upon the game-theoretic concept of "rationalizability", Guesnerie (1992) defines the "rationalizable-expectations equilibria" as the limits of an iterative process which views the farmers' situation as a complete information normal-form game where the set of players is the set of farmers, and their strategies, the farmers' individual quantities of the crop $s_f \in \mathbf{S}_f, \forall f$. [14] Each farmer's payoff function is his profit function:

$$\left\{D^{-1}\left(\int s_{f'} df'\right)\right\} s_f - C\left(s_f, f\right).$$

For each given profile of strategies of the other farmers $\left(s_{f'}\right)_{f' \in [0,1]}$, the best response of farmer f is the function that maximizes the above expression. The concept of a "rationalizable solution" R exhausts the implications of individual rationality and common knowledge (CK) of rationality and of the model when considered as an iterative process taking place in "mental time" τ (in each of the farmers' heads) following which non-best response strategies are progressively eliminated.[15] Where does this iterative process start? At an initial restriction ($\tau = 0$) on the players' strategy sets called *anchorage assumption,* which is either naturally embedded on the model at stark or exogenously given.[16] In either case, it is also CK. This iterative process of elimination of non-best responses will lead somewhere, defined by Pierce (1984) and Bernheim (1984) as a rationalizable solution R :

$$R = \left(s_{f'}\right)_{f'} \in \prod_{f'} \left(\bigcap_{\tau=0}^{\infty} \mathbf{S}(\tau, f') \right).$$

[13] For an explicit formulation of this assertion in the class of models under consideration, see Desgranges and Gauthier (2003), or more recently Jara (2007).

[14] Guesnerie (1992) points out (p.1258) that since the supply function is a one-to-one correspondence of the expected market clearing price, the strategies *are also* the individual price expectations.

[15] Observe that a CK assumption is absolutely rational in a strategic context: when an individual recognizes that self-interest depends on others' actions, his conjectures on others' behaviour are essential to the effective consecution of self intentions. The conjectures are the subjective expectations that each agent forms independently of others. And if one is to form conjectures about others' behaviour, it seems natural to recognize that others form conjectures as well in the same way as one does. Then the agent must conjecture about others' actions and conjectures. This process can go several steps further, triggered by the CK behavioural assumption.

[16] At this stage, it is to be understood not as an exogenous intervention, but as a robustness test that any REE should pass for it to be "implementable" through the iterative process of learning that is being described. If the REE fails to pass the test, then exogenous price restrictions can be introduced by an exogenous third party, to achieve coordination. See Guesnerie (2002) for further details.

Whenever the sets of best response strategies $\mathbf{S}(\tau, f)$ shrink through "mental time" τ to a singleton, farmers instantaneously coordinate on a unique (production) strategy. Because of the one-to-one correspondence between prices and quantities, that production decision will correspond to a price expectation. As market clearing is CK, that price expectation must clear the market, and therefore coincide with the *actual* equilibrium price. As that equilibrium price is the unique rationalizable solution, and because the Nash solution is always rationalizable, the equilibrium price must coincide with the Nash equilibrium of the normal-form game. However, when the sets of farmers' best responses do not collapse to a singleton, full coordination is not achieved. Although the NE will be included in, farmers equivalently consider each of the possible rationalizable strategies as an equilibrium production decision, corresponding each to an equilibrium price expectation.[17]

Guesnerie (1992) otains structural conditions under which, *without assuming that farmers held rational expectations*, the rationalizable expectations equilibrium of the farmers' normal-form game described above coincides with the REE (or NE). The unique rationalizable expectations equilibrium is called by him a "strongly rational expectations equilibrium" (SREE) or "unique rationalizable expectations equilibrium".

3.2 The linear specification

Consider the (non-noisy) linear version of the model presented above. The demand function for the crop is given by:

$$D(p) = \begin{cases} A - Bp & \text{if } 0 \leq p \leq \frac{A}{B} \equiv p_0^{\max} \\ 0 & \text{otherwise} \end{cases}$$

and $C(q, f) = \frac{q^2}{2C_f}$, $f \in [0, 1]$ constitutes the farmers' cost function. Under this linear specification, the PFE price is given by:[18]

$$\overline{p} = \frac{A}{B + C} : C \equiv \int C_f \mathrm{d}f.$$

The game that farmers play has a set of rationalizable strategies given by the limit of the iterative process of elimination of non-best responses from the strategy sets of farmers, depicted in Fig. 1:

The iteration is triggered by the CK of individual rationality and of the model, since the anchorage assumption is embedded in the structure of the model: at virtual

[17] It is important to stress that to compute the rationalizable equilibrium, the subjective price probability distribution and the cost function of every agent as well as market clearing are CK in the model considered. The work by Desgranges and Gauthier (2003) makes clear the distinction between strategic uncertainty and model uncertainty in the linear noisy one-dimensional version of Guesnerie (1992) presented here: they show that whenever the CK assumption on farmers' subjective probability beliefs is violated, the success of the iterative process is compromised.

[18] It can be checked that with the encompassing definition of the demand function $D(p) = \max\{A - Bp, 0\}$, with $p_0^{\max} \equiv \min D^{-1}(0) = \frac{A}{B}$, the PFE price equals $p_0^{\max}$ when total supply is zero.

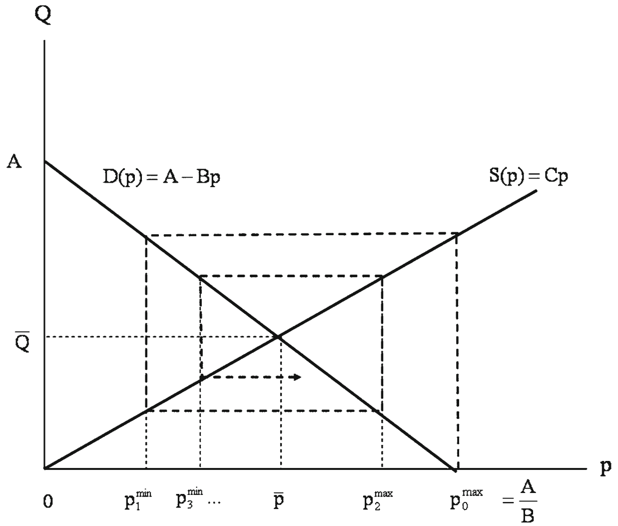

Fig. 1 *Eductive* learning

time $\tau = 0$ each farmer f recognizes that equilibrium prices must be contained in the interval $[0, p_0^{\max}] : p_0^{\max} \equiv \frac{A}{B}$ (maximum willingness to pay) since $D(p_0^{\max}) = 0$. Therefore each farmer deletes from his strategy set any quantity $s_f \geq S(p_0^{\max}, f)$ defining the set $\mathbf{S}(0, f) = \left[0, S(p_0^{\max}, f)\right], \forall f$. At $\tau = 1$ since each farmer knows that other farmers are rational as well, each farmer knows that the others $\forall f' \neq f$ will play strategies in their sets $\mathbf{S}(0, f')$, concluding that total supply cannot be greater than $S(p_0^{\max}) = \int S(p_0^{\max}, f')df'$. From the market clearing equation being common knowledge, each farmer deduces that the equilibrium price cannot be smaller than $p_1^{\min} = D^{-1}\left[S(p_0^{\max})\right]$ and proceeds to delete from his strategy set $\mathbf{S}(0, f)$ all these quantities that are smaller than $s_f \leq S(p_1^{\min}, f)$. The new set of strategies $\mathbf{S}(1, f) = \left[S(p_1^{\min}, f), S(p_0^{\max}, f)\right]$ for every farmer f recognizes that equilibrium prices must be contained in the interval $[p_1^{\min}, p_0^{\max}]$. Now at $\tau = 2$ each farmer recognizes that the other farmers $\forall f' \neq f$ know that he knows, and therefore play also strategies in the set $\mathbf{S}(1, f')\ldots$ and so on. Intuitively, each step τ corresponds to a further logical deduction step progressively exhausting the implications of the CK behavioural assumption and of the initial anchorage restriction triggering it ($p_0^{\max}$). This process leads each farmer to individually reproduce in their heads the following sequence of (expected) prices $(p_\tau)_{\tau=0}^{\infty}$:

$$p_1^{\min} = D^{-1}\left[S(p_0^{\max})\right] = \frac{A}{B} - \frac{C}{B}p_0^{\max}$$

$$p_2^{\max} = \frac{A}{B} - \frac{C}{B}p_1^{\min} = \frac{A}{B}\left[1 + \left(-\frac{C}{B}\right)\right] + \left(-\frac{C}{B}\right)^2 p_0^{\max}$$

$$\cdots$$

$$p_\tau = \frac{A}{B} - \frac{C}{B}p_{\tau-1} = \frac{A}{B}\left[\sum_{m=0}^{m=\tau-1}\left(-\frac{C}{B}\right)^m\right] + \left(-\frac{C}{B}\right)^\tau p_0^{\max}.$$

If this sequence has a limit, from the rationalizable solution concept, it must be the NE of the game $\overline{p}$. We reproduce Guesnerie's (1992) Proposition 1, which establishes conditions under which farmers are able to coordinate on the PFE price $\overline{p}$. Under those conditions the equilibrium is a SREE:

Proposition 1 (Guesnerie 1992) (i) $B > C \iff \overline{p}$ *is an SREE.* (ii) $B \leq C \iff \overline{p}$ *is not an SREE, and the set of rationalizable-expectations price equilibria comprises the segment* $\left[0, p_0^{\max}\right]$

The conclusion of Proposition 1 can be read as 'a low elasticity of aggregate supply (small C) and a high elasticity of demand (large B) favour expectational coordination from an eductive viewpoint' (case depicted in Fig. 1). Intuitively, it can be read also as "producers" forecasts are more reliable the lower the sensibility of their decisions to others' forecasts'. Then under condition (i), the set of farmers' rationalizable strategies that are the rationalizable solution R of the farmers' game is:

$$R = \left(s_{f'}\right)_{f'} \in \prod_{f'}\left(\bigcap_{\tau=0}^{\infty} \mathbf{S}(\tau, f')\right) = \prod_{f'} \mathbf{S}(\infty, f') = \left(S(\overline{p}, f')\right)_{f'}$$

If however, condition (ii) is satisfied, then the price sequence $(p_\tau)_{\tau=0}^{\infty}$ does not have a limit and the set of farmers' rationalizable strategies that are a rationalizable solution R of the farmers' game is:

$$R = \left(s_{f'}\right)_{f'} \in \prod_{f'}\left(\bigcap_{\tau=0}^{\infty} \mathbf{S}(\tau, f')\right) = \prod_{f'} \mathbf{S}(0, f') = \times_{f'} \left[0, S(p_0^{\max}, f')\right]$$

In situations like (ii), Guesnerie (1992) identifies the minimal set of conditions sufficient to achieve full coordination, calling them "credible price restrictions" or "exogenous price interventions", implemented by an exogenous third party.

In this particular example, the model definition embeds the initial anchorage assumption ($p_0^{\max}$, denoted p_0 heretofore) which is not "close" to the equilibrium outcome. Then, under the (i) condition, the equilibrium price is "Globally SR". In general, when no such natural embedding exists, the anchorage assumption is exogenously specified. When the model considered is non-linear, the anchorage assumption is settled "close" to the REE under scrutiny and the analysis is local (because there might exist multiple equilibria, which we assume locally determinate). Then, when the iterative process converges, the equilibrium is called "Locally SR" or "SR with respect to the CK anchorage assumption". When the iterative process does not converge, the "credible price restrictions" or "exogenous price interventions" qualify the above definitions to be "SR with respect to these restrictions". For non-linear versions of the economy under study, the iterative process describing farmers' eductive learning can be characterized by the second iterate of the cobweb function $\varphi(\cdot) \equiv D^{-1}\left[S(\cdot)\right]$, $\varphi^2(\cdot) \equiv \varphi\left[\varphi(\cdot)\right]$, conditional to the CK initial restriction,[19] denoted $V(\overline{p})$:

[19] Subject to the condition that $\lim_{\tau\to\infty}\left(\varphi^2\right)^{\tau}(p_0) = \lim_{\tau\to\infty}\varphi^{2\tau}(p_0) = \overline{p},\ p_0 \in V(\overline{p})$

Proposition 2 (Guesnerie 1992)*:*

(i) *If* $|\varphi'(p)| < 1 \Leftrightarrow S'(p) < |D'[S(p)]|, \forall p$ *and if there is a credible price restriction (floor or ceiling), then* $\overline{p}$ *is a SREE subject to the given price restriction.*

(ii) *If* $|\varphi'(\overline{p})| < 1$*, there is a credible price restriction (floor or ceiling) s.t.* $\overline{p}$ *is a SREE subject to the given price restriction.*

(iii) *If* $|\varphi'(\overline{p})| > 1$*, and if the graph of* $\varphi^2(\cdot)$ *intersects transversely the 45° line more than once, then there is a credible price restriction (floor or ceiling) s.t.* $[p_{c1}, p_{c2}]$ *is the set of rationalizable-expectations equilibrium prices subject to the given price restriction, where* $p_{c2} = \varphi(p_{c1}), \varphi^2(p_{ct}) = p_{ct}, t = 1, 2$ *define cycles of order two of the cobweb function.*[20,21]

The results in the next section illustrate some of these cases.

4 A simple linear model of trade and expectational stability

Most of the international trade literature concerns comparative statics exercises on the effect of changes in the production structure (factor endowments or production techniques) on the equilibrium outcome operated via the mobility of commodities or factors. The consequences on factors and commodity prices are corollaries of the comparative statics exercise under the same or alternative restrictions. However, they all necessitate at least two commodities for the exchange channel to operate. In the class of agricultural economies considered, there is only a single homogenoeus crop produced at different costs depending on farmers' technologies. From the expectational stability viewpoint, the open economy device introduces heterogeneity in the autarkic economy, which according to Guesnerie's (2002) general intuition (GI2), should undermine its expectational stability. A related way to understand the exercise is to assume that non-increasing returns to scale producers play a large oligopoly game with strategic substituabilities, the equilibrium of which is globally perturbed by the integration policy. The question would then be whether the dominance solvability of the autarkic equilibrium is robust to the introduction of heterogeneity (amenable to an open economy device).[22]

Although the answer will be related to the factors favouring coordination upon the integrating regions autarkic equilibrium (Propositions 1, 2 above), the answer is not immediate. Aggregating demand curves in partial equilibrium results in a more elastic demand curve, which favours expectational coordination according to Proposition 1. However, aggregation of supply curves is detrimental to eductive coordination.[23]

[20] For a proof of the general statement which includes cases (ii) of Proposition 1 and this case (iii), see Bernheim (1984), Proposition 5.2., part (a).

[21] This is trivially true if $[p_{c1}, p_{c2}] \subset V(\overline{p})$. If however $V(\overline{p}) \subseteq [p_{c1}, p_{c2}]$, the learning dynamics will also converge to the set $[p_{c1}, p_{c2}]$. In that case, the CK anchorage assumption must be understood not as a "hypothetical" restriction, but as resulting from a non-enforceable "exogenous price intervention".

[22] See Vives (1999) Chap. 4.4. for a synthetic presentation of large Cournot markets.

[23] As Vives (1999) discusses for large Cournot games, the effect parallels adverse impact on dominance solvability of the equilibrium from increasing the number of producers without replicating the demand.

As economic integration entails both, it does not necessarily undermine the coordinational ability of farmers. Actually, *mere replication of the Home economy will not affect its degree of expectational stability*.

To see it, consider the linear class of agricultural economies characterized by linear aggregate demand and supply schedules and index them by $n \in \mathbf{N} = \{1, \ldots, N\}$. In each, a set of risk neutral farmers $f_n \in [0, 1]$ produce with strictly convex cost structures $C(s_{f_n}, f_n, n) = \frac{(s_{f_n})^2}{2C_{f_n}(n)}$ to serve a continuum of consumers represented by a (weakly) decreasing aggregate linear demand function $D_n(p) \equiv \int D_n(p, c_n)\mathrm{d}c_n = \max\{A_n - B_n p, 0\}$.[24] Suppose that the N economies in the class are identical and decide to integrate (fix $n = n_0, \forall n$ and call economy n_0 the Home economy). The aggregate supply of the global agricultural economy will be given by the sum of the aggregate supply functions of each of the N regions, $S(p) = \sum_{n=1}^{N} S_n(p) = N \int C_{f_{n_0}}(n_0) p \mathrm{d} f_{n_0} = N S_{n_0}(p)$. So will the aggregate demand: $D(p) = \sum_{n=1}^{N} D_n(p) = N D_{n_0}(p)$. The PFE-price is then given by:

$$\overline{p} = \overline{p}_{n_0} = \frac{A_{n_0}}{B_{n_0} + C_{n_0}}$$

and the conditions under which farmers will be able to individually predict the PFE-price $\overline{p}$ coincide with those of Proposition 1:

Proposition 3 (i) $B_{n_0} > C_{n_0} \iff \overline{p}$ *is an SREE.* (ii) $B_{n_0} \leq C_{n_0} \iff \overline{p}$ *is not an SREE, and the set of rationalizable-expectations price equilibria comprises the segment* $[0, p_0]$.[25]

The detrimental effect of increasing the number of farmers on the eductive stability of the equilibrium: consider our Home economy $n = n_0$ and suppose that in addition to the Home farmers those from the rest of the regions $\mathbf{N} \setminus \{n_0\}$ can also sell in the Home crop market. Denote by $C_\Sigma = C_{n_0} + \sum_{n \neq n_0} C_n$ the aggregate cost parameter characterizing the total supply of the crop. The PFE price is $\overline{p} = \frac{A_{n_0}}{B_{n_0} + C_\Sigma}$, which when:

Proposition 4 (i) $B_{n_0} > C_\Sigma \iff \overline{p}$ *is an SREE.* (ii) $B_{n_0} \leq C_\Sigma \iff \overline{p}$ *is not an SREE, and the set of rationalizable-expectations price equilibria comprises the segment* $[0, p_0]$. (iii) *Increasing the number of farmers is detrimental to expectational stability.*[26]

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24 Throughout we assume that $A_n, B_n > 0, \forall n \in \mathbf{N}$. Notice that $p_0 \equiv \min D_n^{-1}(0) = \frac{A_n}{B_n}$.

25 This proposition extends to the integration of N identical non-linear agricultural economies under some conditions. See Proposition 9 in Calvo-Pardo (2005).

26 Although this proposition as such does not extend to general non-linear schedules, a stronger version of it does. Section 5 in Calvo-Pardo (2005) discusses it, and Proposition 10(i) contains the results. The problem is connected to the convexity of demand, which in usual Cournot games, prevents the players' reaction functions from being downward sloping, or, players' strategies from being strategic substitutes. See Vives (1999), Chaps. 2 and 4 for a comprehensive explanation.

Proof Compute the limit $\lim_{\tau\to+\infty} p_\tau$ of the price sequence:

$$p_\tau = \frac{A_{n_0}}{B_{n_0}}\left[\frac{1-\left(-\frac{C_\Sigma}{B_{n_0}}\right)^\tau}{1-\left(-\frac{C_\Sigma}{B_{n_0}}\right)}\right] + \left(-\frac{C_\Sigma}{B_{n_0}}\right)^\tau p_0.$$

Part (iii) follows trivially from the definition of C_Σ, (i) and noting that replicating the supply side of the Home economy makes $C_\Sigma = NC_{n_0}$. □

Part (iii) states that the set of rationalizable solutions of the Home economy R_{n_0} will be strictly included in the set of rationalizable solutions of the regionally integrated agricultural economy R of Proposition 3: $R \supset R_{n_0}$. As the aggregation of supply curves increases the elasticity of the resulting aggregate supply schedule (in terms of Fig. 1: keep aggregate demand constant and rotate counter-clockwise aggregate supply), each farmer's quantity choice becomes more sensible to other farmers' choices, rendering their predictions of the market clearing price less accurate (for sufficient entry, the depicted eductive process does not converge). Intuitively, as new entrants gain access to the Home market, the relative scarcity of the home produced commodity decreases, intensifying competition and lowering the price and profits of home producers, compelling their forecasts to increasingly rely on what do others expect, thus undermining expectational coordination. Therefore, *opening the Home market to foreign competitors is destabilizing*, in the precise sense of producers' undermined ability to forecast the market clearing price, and hence, their profits. It is in this sense that "competitiveness" matters: the proposition is silent about the relative efficiency of the new foreign entrants, i.e. foreign entry will be destabilizing even if producing at higher real average costs (in terms of Home purchasing power, as we abstract from aggregate demand changes). Therefore, it is related to a pure scarcity effect relative to autarky, that exists because entry is exogenous.

Replication of Home demand keeping supply constant, highlights the beneficial role of the demand elasticity on the expectational stability of the resulting PFE price, given by $\overline{p} = \frac{NA_{n_0}}{NB_{n_0}+C_{n_0}}$. Then when:

Proposition 5 (i) $NB_{n_0} > C_{n_0} \iff \overline{p}$ *is an SREE.* (ii) $NB_{n_0} \leq C_{n_0} \iff \overline{p}$ *is not an SREE, and the set of rationalizable-expectations price equilibria comprises the segment* $[0, p_0]$. (iii) *Increasing the number of consumers favours stability.*[27]

Proof For parts (i), (ii) compute the limit $\lim_{\tau\to+\infty} p_\tau$ of the price sequence in the previous proposition after replacing $\left(-\frac{C_\Sigma}{B_{n_0}}\right)$ by $\left(-\frac{C_{n_0}}{NB_{n_0}}\right)$. Part (iii) follows from (i) and $NB_{n_0} > B_{n_0}$. □

Intuitively, part (iii) states that as the number of consumers increases, the demand becomes more sensible to price changes because the relative scarcity of the home

[27] Although this proposition as such does not extend to general non-linear schedules, a stronger version of it does. Section 5 in Calvo-Pardo (2005) discusses it, and Proposition 10 (ii) contains the results. See Footnote 25 for the details.

produced commodity increases. Then, higher prices and profits are expected relative to autarky, relaxing home competition and reducing the weight of the strategic component in producers' forecasts (forecasting others' forecasts), which favours expectational coordination (in Fig. 1: keep aggregate supply constant and rotate clockwise aggregate demand; the depicted eductive process is more likely to converge). Therefore, *opening new markets for the Home producers is stabilizing*, in the precise sense that producers' expectations become more reliable.[28]

4.1 From global to local stability conditions

In the class of linear economies considered, the anchorage assumption is embedded in the model ($p_0 = \frac{A_n}{B_n}, \forall n$) and "global", in the sense that it is not "close" to the equilibrium. The same is true for the PFE price of the economically integrated region, provided that the consumers of different regions value the crop "similarly", i.e. provided that consumers' maximal willingness to pay is identical across regions: $\frac{A_n}{B_n} = \frac{A_{n'}}{B_{n'}}, \forall n, n' \in \mathbf{N}$.

With the same notation as previously, we define the regionally integrated demand and supply by $D(p) = \max\{A_\Sigma - B_\Sigma p, 0\}$ and $S(p) = C_\Sigma p$, respectively. Then the free trade PFE price is:

$$D(\overline{p}) = S(\overline{p}) \Longleftrightarrow \overline{p} = \frac{A_\Sigma}{B_\Sigma + C_\Sigma}$$

and will be expectationally stable if:

Proposition 6 *Assuming that* $\frac{A_n}{B_n} = \frac{A_{n'}}{B_{n'}}, \forall n, n' \in \mathbf{N}$, *then:* (i) $B_\Sigma > C_\Sigma \Longleftrightarrow \overline{p}$ *is an SREE.* (ii) $B_\Sigma \leq C_\Sigma \Longleftrightarrow \overline{p}$ *is not an SREE, and the set of rationalizable-expectations price equilibria comprises the segment* $[0, p_0] : p_0 = \frac{A_\Sigma}{B_\Sigma}$. (iii) *The regional integration of N autarkically expectationally stable economies is expectationally stable, but the converse is false.*

Proof See Appendix 1. □

Intuitively, part (iii) states that it is not regional integration *per se* what undermines expectational coordination, but the integration with expectationally unstable regions. And even then, if the set of stable economies is sufficiently stable, for an autarkically unstable region *economic integration can favour expectational coordination,* against Guesnerie's (2002) general intuition (GI2), i.e. that heterogeneity is detrimental to expectational coordination.[29]

[28] Proposition 5 becomes the exact analogue of Proposition 4, defining $D(p) = \max\left\{\sum_n (A_n - B_n p), 0\right\} \equiv \max\{A_\Sigma - B_\Sigma p, 0\}$ *and imposing the additional condition* $\frac{A_n}{B_n} = \frac{A_{n'}}{B_{n'}}, \forall n, n' \in \mathbf{N}$. The latter condition imposes the equality of the maximal willingnesses to pay for the crop across regions, and its role on the expectational stability of the free trade equilibrium price is examined in the next two subsections.

[29] The last subsection qualifies this conclusion.

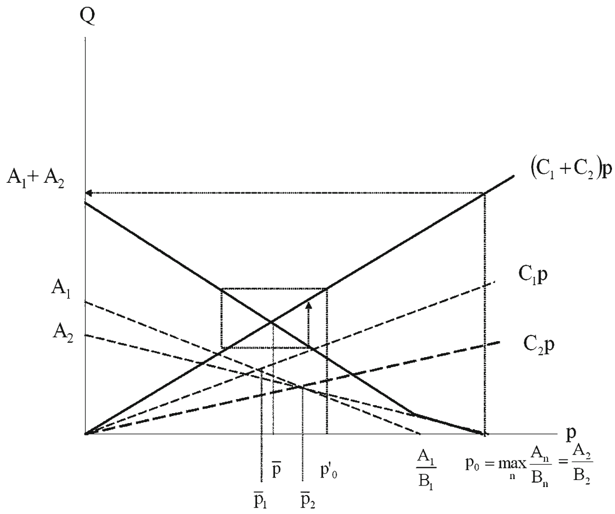

Fig. 2 *Eductive* stability fails "globally" but not "locally"

However, removing the condition of equality of maximal willingnesses to pay in Proposition 6 results in a non-linear (piece-wise linear) aggregate demand under free trade, rendering piece-wise linear the cobweb characterization of the eductive learning process,[30] with two main consequences: First, from the comparison of Guesnerie's (1992) Propositions 1 and 2, the necessity of an "exogenous price intervention" is more stringent if expectational coordination is to be maintained at the global level.[31] Second, conditions for its convergence are given by Proposition 2. There, expectational stability is secluded by resorting to a local analysis (setting p_0 "close" to $\overline{p}$), which poses a problem for our exercise since the CK anchorage assumption is naturally embedded in the model and not necessarily "close" to the PFE (given by the maximum willigness to pay across regions, i.e. $p_0 = \max_n \frac{A_n}{B_n}, n \in \mathbf{N}$).[32] There is then a conflict between the naturally embedded CK anchorage assumption (denoted p_0) and the "wishful" CK anchorage assumption for the study of non-linear models (denote it by p'_0, and set p'_0 "close" to $\overline{p}$), as exemplified in the following two figures:

In Fig. 2 the global "expectational stability test" (starting in p_0) fails and nevertheless the PFE price is locally expectationally stable (starting in p'_0), i.e. depicts Proposition 2(ii). In Fig. 3, the global "expectational stability test" is passed (starting in p_0), although the PFE price is locally expectationally unstable (starting in p'_0). Figure 3 illustrates Proposition 2(iii). Notice that both regions are expectationally

[30] Notice that in autarky, the coweb characterization of the eductive process is linear.

[31] This is reminiscent of the traditional need to coordinate regional social planners at the open economy level to fulfill pre-trade national goals. It can then be understood as a new "rationale" justifying an exogenous intervention after integration. We however leave for future work the characterization of the instruments and the study of their effective implementation in the current framework.

[32] This is the class of inconsistent situations adduced to by Guesnerie (2002), case I.2.(i).

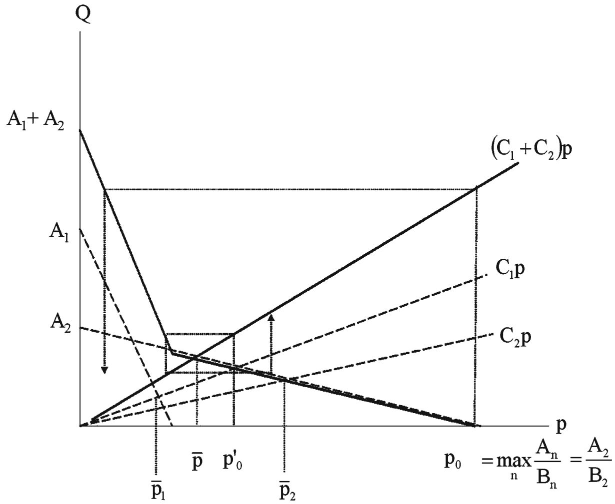

Fig. 3 *Eductive* stability fails "locally" but not "globally"

stable in autarky. In the next subsection we fully develop a two-region example and extend Proposition 6 to the case where condition $\frac{A_n}{B_n} = \frac{A_{n'}}{B_{n'}}, \forall n, n' \in \mathbf{N}$ does not hold.

4.2 A robust example

Consider the regional integration of two economies $n = \{1, 2\}$ in the linear class $\mathbf{N}$, such that $\frac{A_2}{B_2} \geq \frac{A_1}{B_1}$.[33] Accordingly, and from the definition of regional demands, $p_0^n \equiv \min D_n^{-1}(0) = \frac{A_n}{B_n}, n = 1, 2$. Keeping the same notation, after integration farmers' demand will be $D(p) = \sum_n D_n(p)\mathbf{1}_{\{p \leq p_0^n\}}$, where $\mathbf{1}_{\{p \leq p_0^n\}}$ denotes the standard indicator function, taking value 1 only if the n-region consumers can afford to buy the crop at price p, and zero otherwise.[34] Then, the PFE price $\overline{p}$ will be given by:

$$\overline{p} = \max\left\{\frac{A_\Sigma}{B_\Sigma + C_\Sigma}, \frac{A_2}{B_2 + C_\Sigma}\right\}.$$

Figures 4 and 5 below build upon the case depicted in Fig. 3. The PFE price is represented in Fig. 4 as a function of the aggregate supply cost parameter $C_\Sigma, \overline{p}(C_\Sigma) = \max\left\{\overline{p}^1(C_\Sigma), \overline{p}^2(C_\Sigma)\right\}$, corresponding to the above expressions. We have parameterized the difference in the maximal willingnesses to pay by

[33] We will assume throughout that the region with a relatively more elastic demand will have the lower maximal willigness to pay for the crop, i.e. $A_1 \geq \cdots \geq A_N > 0$ and $B_1 \geq \cdots \geq B_N > 0$. Then when $n = \{1, 2\}$, $\min_n A_n = A_2$ and $\min_n B_n = B_2$. These assumptions can be dispensed with and the conclusions still hold.

[34] In this particular example, we can alternatively characterize the demand function as $D(p) = \max\{A_\Sigma - B_\Sigma p, A_2 - B_2 p, 0\}$.

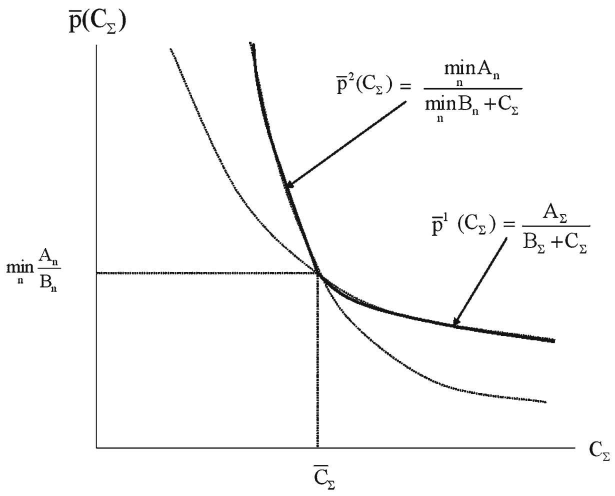

Fig. 4 *Free trade* PFE

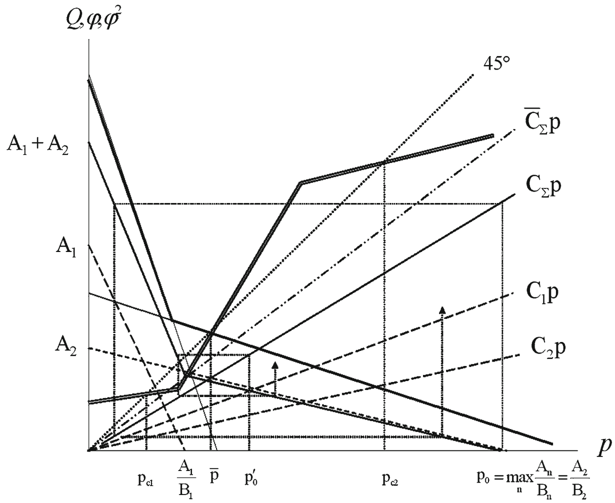

Fig. 5 *Free trade* undermines expectational coordination

$\overline{C}_\Sigma = A_2\left[\frac{B_1}{A_1} - \frac{B_2}{A_2}\right]$. We can see that the PFE price changes for values of the aggregate supply cost parameter above and below $\overline{C}_\Sigma$. Values of C_Σ above $\overline{C}_\Sigma$ indicate that both regional markets will be served after integration, whereas values below indicate that only the highest valuation region will be served ($n = 2$, given our assumptions). When $\overline{C}_\Sigma = 0$ maximal willingnesses to pay are equal across regions (Proposition 6).

The learning dynamics of the regional integration PFE price are characterized by the piece-wise linear cobweb function $\varphi(p) \equiv D^{-1}[S(p)]$, with the following analytic form:[35]

$$\varphi(p; C_\Sigma) = \max\left\{\varphi_1(p; C_\Sigma \geq \overline{C}_\Sigma), \varphi_2(p; C_\Sigma \leq \overline{C}_\Sigma)\right\}$$
$$= \begin{cases} \varphi_2(p; C_\Sigma \leq \overline{C}_\Sigma) & \text{if } p \leq p^i \\ \varphi_1(p; C_\Sigma \geq \overline{C}_\Sigma) & \text{if } p \geq p^i \end{cases}$$

where $\varphi_1(p; C_\Sigma \geq \overline{C}_\Sigma) = \frac{A_\Sigma}{B_\Sigma} - \frac{C_\Sigma}{B_\Sigma} p$ coincides with the linear cobweb function characterizing the learning dynamics when the condition $\frac{A_1}{B_1} = \frac{A_2}{B_2} \Longleftrightarrow \overline{C}_\Sigma = 0$ is satisfied, while $\varphi_2(p; C_\Sigma \leq \overline{C}_\Sigma) = \frac{A_2}{B_2} - \frac{C_\Sigma}{B_2} p$ corresponds to the case in which $\frac{A_2}{B_2} \geq \frac{A_1}{B_1}$ *and* $C_\Sigma \leq \overline{C}_\Sigma$. Therefore, when $\frac{A_2}{B_2} \geq \frac{A_1}{B_1}$ *but* $C_\Sigma \geq \overline{C}_\Sigma$, the conclusions of Proposition 6 apply even if maximal willingnesses to pay across regions differ. Finally, p^i is the price at which both functions $\varphi_1(\cdot), \varphi_2(\cdot)$ intersect.[36]

In Fig. 5, we have depicted in solid black the cobweb function $\varphi(\cdot)$ when $\frac{A_2}{B_2} \geq \frac{A_1}{B_1}$ *and* $C_\Sigma \leq \overline{C}_\Sigma$; i.e.only region 2 consumers will be able to afford the consumption of the crop at the prevailing free trade PFE price $\overline{p}$. Notice that the conclusions of Proposition 6 do not hold: the global "expectational stability test" is satisfied (starting at p_0), but the PFE price is locally expectationally unstable (starting at p_0'). When the economy under study is non-linear, Proposition 2 above provides conclusions on the basis of the second iterate of the cobweb function $\varphi^2(\cdot)$, given by:[37]

$$\varphi^2(p) = \begin{cases} (\varphi_1 \circ \varphi_2)(p) & \text{if } \quad p \leq p^i_{\text{inf}} \\ (\varphi_1 \circ \varphi_1)(p)\mathbf{1}_{\{p^i_{\text{inf}} = p^i\}} + (\varphi_2 \circ \varphi_2)(p)\mathbf{1}_{\{p^i_{\text{inf}} = p^{i\prime}\}} & \text{if } \quad p \in \left(p^i_{\text{inf}}, p^i_{\text{sup}}\right), \\ (\varphi_2 \circ \varphi_1)(p) & \text{if } \quad p \geq p^i_{\text{sup}} \end{cases}$$

where $p^{i\prime}$ denotes a second intersecting price[38] satisfying $\varphi_1\left[\varphi(p^{i\prime})\right] = \varphi_2\left[\varphi(p^{i\prime})\right]$. We define $p^i_{\text{inf}} = \max\left\{\min\left\{p^{i\prime}, p^i\right\}, p_1'\right\}$ and $p^i_{\text{sup}} = \min\left\{\max\left\{p^{i\prime}, p^i\right\}, p_\infty\right\}$, which constitute the two non-differentiability points of the piece-wise linear function $\varphi^2(\cdot)$. Finally $\mathbf{1}_{\{p^i_{\text{inf}} = p^i\}}$ takes value 1 if $p^i_{\text{inf}} = p^i$ and 0 otherwise. $\varphi^2(\cdot)$ is depicted in Fig. 5 as the double-solid piece-wise linear curve -for the parameters considered, its shape describes Proposition 2(iii). $\varphi^2(\cdot)$ displays the following properties: it is monotonically increasing, satisfies $\varphi^2(\overline{p}) = \varphi\left[\varphi(\overline{p})\right] = \varphi(\overline{p}) = \overline{p}$, and for the particular parameterization represented in Fig. 5, the two non-differentiability points are given by $p^{i\prime} > p^i = \min_n \frac{A_n}{B_n} = \frac{A_1}{B_1}$.

35 That $\varphi'(\cdot) \leq 0$ and $\varphi(\overline{p}) = \overline{p}$ are general properties of the cobweb function in the class of economies under study. For a proof, the reader can consult Appendix 1 in Calvo-Pardo (2005).

36 For the derivation of the cobweb function and the expression of the intersection price, see Appendix 1 in Calvo-Pardo (2005).

37 Notice that the learning dynamics characterized by it adopt the form of a functional piece-wise linear difference equation. See in Calvo-Pardo (2005) Appendices 2 for the derivation, and 3 for its properties, respectively.

38 See Appendix 2 in Calvo-Pardo (2005) for the characterization of p_1' (and p_∞) and its properties, although the interest of it is merely technical.

Figure 5 also illustrates the two main consequences adduced to: first, even if both regions were expectationally stable before integration, the resulting PFE price is "expectationally unstable" after integration, in line with the intuition that *heterogeneity is detrimental to expectational coordination*. Second, the embedded anchorage assumption $p_0 = \max_n \frac{A_n}{B_n} = \frac{A_2}{B_2}$ is not "local" and the learning process converges to the set $[p_{c1}, p_{c2}]$ of rationalizable-expectations equilibria, containing $\overline{p}$. If the "local" approach had been adopted instead, the initial price restriction (denoted p_0'), would have been set in a neighbourhood of the PFE, $N_\epsilon(\overline{p}) = (\overline{p} - \epsilon, \overline{p} + \epsilon)$, and the learning dynamics would diverge from $\overline{p}$, but converged to $[p_{c1}, p_{c2}]$.

The most salient result is then:

Proposition 7 *Set* $\mathbf{N} = \{1, 2\}$. *If* $C_\Sigma \geq \overline{C}_\Sigma$ *the results of Proposition 6 extend to the case where* $\exists n, n' \in \mathbf{N} : \frac{A_n}{B_n} \neq \frac{A_{n'}}{B_{n'}}$. *If however,* $C_\Sigma < \overline{C}_\Sigma$ *then even if both economies were autarkically expectationally stable, the global equilibrium price can end up being unstable.*

Proof (See the results in Table 1 in Appendix 1, and the corresponding proofs in Appendix 4 of Calvo-Pardo (2005)) □

Intuitively, a large disparity in consumers' regional valuations renders farmers' forecasts increasingly unreliable because it renders a "market disruption" phenomenon more likely: If as a result of regional integration the PFE price is "too high", the consumers from the low-valuation region will be excluded ("market disruption") with the adverse net effect of a pure increase in the number of Home farmers' competitors, studied in Proposition 4.

The next proposition generalizes this result to the regional integration of N economies in the linear class, such that $\exists n, n' \in \mathbf{N} : \frac{A_n}{B_n} \neq \frac{A_{n'}}{B_{n'}}$. From the discussion of the previous example, we adopt a "local" approach of convergence of the learning dynamics. Proposition 2 characterizes the local eductive stability condition, which can be rewritten as:

$$\varphi'(\overline{p}) = \varkappa_{\{n:\overline{p}\leq p_0^n\}} \left[\sum_n \frac{D_n'(\overline{p})}{\sum_n D_n'(\overline{p})} \varphi_n'(\overline{p}) \right]$$
$$= \varkappa_{\{n:\overline{p}\leq p_0^n\}} \left[\sum_n \alpha_n \varphi_n'\left(\overline{p}_n\right) \right].$$

The second equality follows from linearity, $\varphi_n'(\overline{p}) = \varphi_n'\left(\overline{p}_n\right)$, $\forall n$. The factor $\varkappa_{\{n:\overline{p}\leq p_0^n\}}$ captures the possibility of spatial differences in the maximal willingnesses to pay, and is defined as:

$$\varkappa_{\{n:\overline{p}\leq p_0^n\}} \equiv \frac{\sum_n D_n'(\overline{p})}{\sum_{n:\overline{p}\leq p_0^n} D_n'(\overline{p})} \geq 1$$

with $\sum_{n:\overline{p}\leq p_0^n} D_n'(\overline{p}) = \sum_n D_n'(\overline{p}) \mathbf{1}_{\{\overline{p}\leq p_0^n\}}$, from taking the price derivative of the regionally integrated demand function. The denominator sums the regional demand elasticities at the open economy equilibrium price, whenever the quantities demanded are positive. The numerator sums the regional demand elasticities irrespectively of whether open economy equilibrium quantities are positive or not. Finally, whenever the consumers of all the integrating regions can afford consumption at the free-trade equilibrium price, the numerator and the denominator of the above expression coincide and $\varkappa_{\{n:\overline{p}\leq p_0^n\}} = 1$. Whenever it is not the case, $\varkappa_{\{n:\overline{p}\leq p_0^n\}} > 1$. Then:

Proposition 8 *For* $\mathbf{N} = \{1, \ldots, N\}$, *if* $\exists n, n' \in \mathbf{N} : \frac{A_n}{B_n} \neq \frac{A_{n'}}{B_{n'}}$, *then the regional integration of autarkic expectationally stable economies can be expectationally unstable. It is more likely so, the larger the disparity in the willingnesses to pay across regions* $\varkappa_{\{n:\overline{p}\leq p_0^n\}}$.

Proof See Appendix 2. □

Next, we uncover an additional destabilizing force absent from the linear class of economies **N**: even imposing equality of maximal willignesses to pay across regions, the economic integration of expectationally stable regions can end up being expectationally unstable.

4.3 What the linear model does not say

Suppose that regional demand and supply schedules are allowed to be non-linear, and index them by $m \in \mathbf{M} = \{1, \ldots, M\}$. The following condition guarantees that, with the appropriate boundary behaviour, the PFE are unique (both autarkic and regionally integrated) and therefore (globally) determinate:

Condition (A.1.) $\forall p \in [0, p_0^m)$, $D_m'(p) < 0$, $S_m'(p) > 0$; $p_0^m \equiv \min (D_m)^{-1}(0) > 0$; $S_m(0) = 0$; $D_m(\cdot), S_m(\cdot) \in C^1$; $\forall m \in \mathbf{M}$.[39]

Uniqueness of the regionally integrated PFE price $\overline{p}$ then follows from (A.1.), appropriate boundary conditions[40] and from the fact that the cobweb function is decreasing in the relevant price domain:

$$\varphi'(p) = \frac{\sum_m S_m'(p)}{\sum_{m:p\leq p_0^m} D_m'(p)} < 0, \quad \forall p \in [0, \max_m p_0^m - \varepsilon].$$

Choose a CK initial price restriction that is "close" to the PFE price (in a neighbourhood around it), $p_0 \in N_\epsilon(\overline{p}) = (\overline{p} - \epsilon, \overline{p} + \epsilon)$. Whenever the learning process converges to it, we will say that the equilibrium is locally strongly rational (LSR). Since $\overline{p}$ is locally determinate, applying the implicit function theorem to the market clearing equation $D(\overline{p}) = S(\overline{p})$, we obtain the following condition characterizing the

39 Notice that (A.1.) does not restrict the second derivatives of the supply and demand schedules, and also that $S_m'(\cdot) > 0$ implies that the underlying regional costs are convex.

40 The boundary conditions are: $\sum_m [D_m(0) - S_m(0)] > 0$, and, for a small $\varepsilon > 0$: $\sum_m \left[D_m\left(\max_m p_0^m - \varepsilon\right) - S_m\left(\max_m p_0^m - \varepsilon\right)\right] < 0$.

learning dynamics from Proposition 2(ii) above:

$$\lim_{\tau\to\infty}(p_\tau-\overline{p})=\left(\frac{S'(\overline{p})}{D'(\overline{p})}\right)^{\tau}(p_0-\overline{p})=0\Leftrightarrow\left|\varphi'(\overline{p})\right|=\left|\frac{S'(\overline{p})}{D'(\overline{p})}\right|<1.$$

Since our purpose is to relate the condition for the expectational stability of the regionally integrated equilibrium to the autarkic stability ones, we can expand it as:

$$\varphi'(\overline{p})=\frac{\sum_m S'_m(\overline{p})}{\sum_{m:\overline{p}\le p_0^m}D'_m(\overline{p})}=\varkappa_{\{m:\overline{p}\le p_0^m\}}\sum_m\alpha_m\frac{D'_m(\overline{p}_m)}{D'_m(\overline{p})}\frac{S'_m(\overline{p})}{S'_m(\overline{p}_m)}\varphi'_m(\overline{p}_m),$$

where the $\alpha_m\ge 0,\forall m:\sum_m\alpha_m=1$ represent the relative (to the world) demand elasticities of each of the integrating economies evaluated at the free trade PFE price $\overline{p}$, $\alpha_m\equiv\frac{D'_m(\overline{p})}{\sum_m D'_m(\overline{p})}$. $\overline{p}_m$ is the autarky PFE price of each m region. The factor $\varkappa_{\{m:\overline{p}\le p_0^m\}}\equiv\frac{\sum_m D'_m(\overline{p})}{\sum_{m:\overline{p}\le p_0^m}D'_m(\overline{p})}$ accounts for differences in the maximal willingnesses to pay across the integrating regions. Then:

Proposition 9 *Even if there are no differences in the maximal willingnesses to pay across regions* ($\varkappa_{\{m:\overline{p}\le p_0^m\}}=1$)*, the regional integration of M autarkic expectationally stable economies can result in an expectationally unstable PFE price.*

Proof See Appendix 2. □

Intuitively, the proposition states that *although regional integration stabilizes autarky prices across regions,*[41] *it can destabilize producers' expectations*, *rendering more compelling the necessity of an 'exogenous price intervention' than it was in autarky*. The study of expectational stability in the non-linear class of economies formalizes the intuition that heterogeneity is detrimental to expectational coordination (Guesnerie's (2002), GI2), providing an open economy interpretation of the forces behind: because economic integration equalizes pre-trade prices across regions, it creates a redistributional conflict between heterogeneous producers, leading the more productive to expect higher prices, and the less, lower ones. However now each will react differently, as optimally dictated by the elasticity of their individual supply curves. Since the higher the degree of heterogeneity in the responses is, the more difficult it becomes for them to individually forecast, it is intuitive that the likelihood of successful coordination (on the open economy PFE price) decreases. Stated more formally, as expectational stability is characterized by a condition on first derivatives, the consequences of policy changes upon it are characterized by a condition on second derivatives. Second derivatives precisely measure the *magnitude* of the individual reactions to the policy change which, because of its redistributive nature, embodies expectations of a different *sign*. Hence, the result of the proposition. The same explanation holds for Propositions 7 and 8, because differences in consumers'

[41] In the sense that $\overline{p}\in\left[\min_m\overline{p}_m,\max_m\overline{p}_m\right]$. Proposition 12 in Calvo-Pardo (2005) proves this assertion in the present context.

willingnesses to pay allow differences in the *magnitude* of producers' reactions across regions in *real* cost terms, i.e. in costs per unit of regional purchasing power.[42] It is however, absent in the linear class if maximal willingnesses across regions are equalized, because the linear class forces the *magnitude* of the individual reactions to be the same (second derivatives are zero).

5 Coordination and welfare

An important rationale motivating open economy exercises are welfare considerations. In this section we compare standard welfare gains from free trade in partial equilibrium with the coordinational considerations studied in the previous sections. However, the nature of the exercise is necessarily from an ex-ante viewpoint (before integration takes place) and can be described as follows: Suppose that a given economy is considering with which region to integrate among those in a given class. A possible evaluation criterion is welfare, disregarding coordinational issues. Another evaluation criterion is expectational coordination. If we compare the recommendations of both, do they coincide? The answer illustrates the described trade-off: *standard efficiency gains associated with economic integration have to be weighted against the diminished plausibility of the PFE price in terms of its predictability after integration,* (Proposition 9).[43]

Consider the linear class of economies where farmers face the same aggregate demand function, $D_n(p) = D(p)$, $\forall n$, but differ in their cost structures across regions. The integrated economy will be more efficient than the autarkic ones if we measure efficiency by the net change in the Marshallian aggregate surplus (net producers' profits plus net consumers' surplus) and this change is positive.[44] We slightly change notation relative to the previous sections: now p^* (instead of $\overline{p}$) denotes the integration equilibrium price, while $\overline{p}_n$ still denotes the autarkic equilibrium price of region n. Then, the increase in welfare from integration for a given n region is then defined by:

$$\Delta W_n \equiv W_n^* - \overline{W}_n = \Delta CS_n - \Delta \Pi_n$$
$$= \int_{p^*}^{\overline{p}_n} D_n(p)\mathrm{d}p - \int_{p^*}^{\overline{p}_n} S_n(p)\mathrm{d}p.$$

42 For the sake of completeness, we let the reader remark that when differences in the maximal willingnesses to pay are allowed across economies in the non-linear class **M** ($\varkappa_{\{m:\overline{p}\leq p_0^m\}} \geq 1$), the free trade PFE price is *even* more difficult to forecast. The proof follows the steps of Proposition 8 and is immediate once we notice that:

$$\varphi'(\overline{p}) = \varkappa_{\{m:\overline{p}\leq p_0^m\}} \sum_m \alpha_m \varphi_m'(\overline{p})$$

43 Guesnerie (2000).

44 Since there are no general equilibrium effects, two economies in the class considered here have an incentive to integrate when appropriate redistributional schemes are implemented. For a more detailed discussion, see (Mas-Colell et al. (1995), Sect. 10.E).

It can be seen that a conflict exists between the consumers and the producers of each of the integrating economies. The economy with the relatively more performant producers[45] ($\max_n C_n$) experiences an increase in profits ($\Delta\Pi_n > 0$) from selling abroad part of their production at a price p^* higher than the autarkic one $\overline{p}_n$. This increase in the price damages the consumers living in that region, who see their consumer surplus eroded relative to the autarkic situation, $\Delta CS_n < 0$. The converse happens in the region with the least performant producers ($\min_n C_n$). But, the aggregate surplus increases after integration in each of the integrating economies:[46]

$$\Delta W_n = \int_{p^*}^{\overline{p}_n} [A - Bp]\,\mathrm{d}p - \int_{p^*}^{\overline{p}_n} [C_n p]\,\mathrm{d}p$$

$$= \left[\frac{Ap}{2}\left\{2 - \frac{B + C_n}{A} p\right\}\right]_{p^*}^{\overline{p}_n} = \frac{B + C_n}{2}\left[\overline{p}_n - p^*\right]^2 > 0, \quad \forall n$$

because of this fact, we can assume that national (internal lump-sum ex-post) transfer schemes exist that are able to (more than) compensate the adversely affected party. This is always possible in this partial equilibrium framework, and everybody can be made strictly better off after integration.[47]

From this ex-ante welfare evaluation criterion, a given economy in the linear class would ideally choose an integration partner with which the increase in the net aggregate surplus is maximized. Region H must decide with which of the two region types (F or A) would it integrate, assuming that the producers in region F are more performant than those in the H region, while those in region A are less:

$$+\infty > C_{\mathrm{F}} > C_{\mathrm{H}} > C_{\mathrm{A}} > 0.$$

Call the resulting integrated equilibrium prices $p^*_{\mathrm{H+F}}$ and $p^*_{\mathrm{H+A}}$. From the analytic expression of the net welfare gains in region n, ΔW_n, we can see that

$$0 \in \arg \sup_{C_{\mathrm{A}}: C_{\mathrm{A}} \le C_{\mathrm{H}}} \Delta W_{\mathrm{H}}^{\mathrm{H+A}} = \frac{B + C_{\mathrm{H}}}{2}\left[\overline{p}_{\mathrm{H}} - p^*_{\mathrm{H+A}}(C_{\mathrm{A}})\right]^2.$$

Because, given the autarky price in the home region $\overline{p}_{\mathrm{H}}$, the largest possible value of the integrated economy equilibrium price $p^*_{\mathrm{H+A}}$ is obtained when the less performant

45 Note that with the specified cost structures, $\partial_{C_f} C(q_f, f) = -\left(\frac{q_f}{\sqrt{2}C_f}\right)^2 < 0$. Therefore, higher values of the cost parameter C_f correspond to lower production costs, and to a relatively more performant production technique.

46 Where $C_\Sigma = \sum_n C_n$ denotes the parameter of the total cost function in the integrated economy $C_\Sigma(q)$. Notice that, with an abuse of notation, we denote both a given integrating region and the summation subindex by n.

47 Individual lump-sum transfer schemes could have been implemented in the way proposed by Dixit and Norman (1980) (Sect. 3.2.), since the partial equilibrium economy is a particular case of the general equilibrium economy they consider.

among the abroad regions (A) is selected, i.e. as $C_A \longrightarrow 0$. Since the home region (H) is more efficient, autarky prices are going to be lower: $p^*_{\mathrm{H+A}} - \overline{p}_{\mathrm{H}} > 0$. As this difference is maximal whenever $C_{\mathrm{A}} \longrightarrow 0$, denote by $\overline{\varpi}$ its maximum value:

$$\overline{\varpi} = \lim_{C_{\mathrm{A}} \longrightarrow 0} p^*_{\mathrm{H+A}}(C_{\mathrm{A}}) - \overline{p}_{\mathrm{H}} = \frac{A}{B + \frac{C_{\mathrm{H}}}{2}} - \frac{A}{B + C_{\mathrm{H}}} > 0$$

Now, selecting among the foreign economies (F) that are more efficient than the home region, is there one that allows the home region to attain this same level of welfare $\Delta W_{\mathrm{H}}^{\mathrm{H+A}}(\overline{\varpi}) = \frac{B+C_{\mathrm{H}}}{2}[\overline{\varpi}]^2$? Since the foreign economy (F) is more efficient, the integrated economy equilibrium price will be lower than the autarky equilibrium price at home (H), $\overline{p}_{\mathrm{H}} - p^*_{\mathrm{H+F}} > 0$. Then our problem can be stated formally as:

$$\exists C_F : \overline{p}_{\mathrm{H}} - p^*_{\mathrm{H+F}}(C_{\mathrm{F}}) > \overline{\varpi}.$$

To prove this statement, we are going to proceed as follows: first, we are going to show that there exists a foreign region with a cost function parameter $\overline{C}_{\mathrm{F}}$ such that the home economy reaches the level of welfare $\Delta W_{\mathrm{H}}^{\mathrm{H+A}}(\overline{\varpi})$. Then, we are going to show that there is a set of more performant foreign regions, the integration of home with which yields strictly larger welfare gains. Finally, we show that as the home region becomes more efficient, it also becomes increasingly difficult to find such an F-region, in the sense that the "measure" of the set of F-regions the integration with which yields larger expected welfare gains for the H-region approaches zero.

First, $\overline{C}_{\mathrm{F}} = C_{\mathrm{H}}\left(2 + \frac{C_{\mathrm{H}}}{B}\right)$ satisfies the equation:[48]

$$\overline{p}_{\mathrm{H}} - p^*_{\mathrm{H+F}}(\overline{C}_{\mathrm{F}}) = \overline{\varpi} \Longrightarrow \Delta W_{\mathrm{H}}^{\mathrm{H+F}}(\overline{\varpi}) = \Delta W_{\mathrm{H}}^{\mathrm{H+A}}(\overline{\varpi}).$$

Second, geometrically notice that $\overline{C}_{\mathrm{F}} + C_{\mathrm{H}} = \tan \overline{\theta}_{\mathrm{F+H}}$. Provided that the home economy has an aggregate cost parameter strictly bounded from above, $C_{\mathrm{H}} < +\infty$, and that it is not "too expectationally unstable", $\frac{C_{\mathrm{H}}}{B} < M < +\infty$, then $\overline{C}_{\mathrm{F}} + C_{\mathrm{H}} = C_{\mathrm{H}}\left(3 + \frac{C_{\mathrm{H}}}{B}\right)$ will also be strictly bounded above: $\arctan C_H\left(3 + \frac{C_{\mathrm{H}}}{B}\right) = \overline{\theta}_{\mathrm{F+H}} < \frac{\pi}{2} = \arctan(+\infty)$. By continuity, there will exist a $\delta > 0 : \overline{\theta}_{\mathrm{F+H}} < \overline{\theta}_{\mathrm{F+H}} + \delta < \frac{\pi}{2}$ which will correspond to a foreign region with an aggregate cost parameter $C_{\overline{F}} < +\infty : C_{\overline{\mathrm{F}}} + C_{\mathrm{H}} = \tan\left[\overline{\theta}_{\mathrm{F+H}} + \delta\right] = C_{\mathrm{H}}\left(3 + \frac{C_{\mathrm{H}}}{B}\right) + \Delta C$ and that will generate a

48 For the class of linear economies considered with identical aggregate demand, the F-region with a value of the aggregate cost parameter $\overline{C}_F$ that satisfies the above equation, must equivalently satisfy the condition:

$$\frac{B + \overline{C}_{\mathrm{F}}}{B + C_{\mathrm{H}}} = \left.\frac{B + C_{\mathrm{H}}}{B + C_{\mathrm{A}}}\right|_{C_{\mathrm{A}}=0}$$

Whenever this condition is respected, the welfare gains for the home region from integrating with a more efficient (F) or with a less efficient (A) economy are the same, for economies in the linear class considered. Obviously the set of such F regions is of zero measure in the set of economies considered.

strictly larger welfare gain for the home economy:

$$\Delta W_{\mathrm{H}}^{\mathrm{H}+\overline{\mathrm{F}}} > \Delta W_{\mathrm{H}}^{\mathrm{H}+\mathrm{F}}(\overline{\omega}) \Longleftrightarrow \Delta C > 0$$

which is true by construction. Therefore, home integration with an F-region characterized by an aggregate cost parameter $C_{\overline{\mathrm{F}}}$ displays strictly larger welfare gains than with the best possible integration partner in the set of A-regions.

Finally, under the just stated conditions, there exists an infinity of foreign regions (F) that satisfy this condition, but the size of the set becomes smaller the more efficient the home region is, i.e. the larger the value of the parameter C_H. If we put a uniform probability measure on $\left[0, \frac{\pi}{2}\right]$ we can interpret the expression

$$1 - \mu\left[\overline{\theta}_{\mathrm{F+H}}\right] = \int_{\overline{\theta}_{F+H}}^{\frac{\pi}{2}} \frac{2}{\pi} \mathrm{d}v = 1 - \frac{\arctan C_{\mathrm{H}}\left(3 + \frac{C_{\mathrm{H}}}{B}\right)}{\frac{\pi}{2}}$$

as the likelihood of finding one such F-region the integration with which provides higher welfare gains for the home region than integration with the best candidate in the set of A-regions. Then, from $\lim_{C_{\mathrm{H}} \to +\infty} \left\{1 - \mu\left[\overline{\theta}_{\mathrm{F+H}}\right]\right\} = 0$ we conclude that the more efficient the home region is, the lower the probability of finding an F-region the integration with which will yield the same welfare gains for home than integration with the best candidate A-region (all relatively less performant).

Now, the important point to be noted about this ex-ante welfare evaluation of the potential partner with which to integrate is that, the less performant the integrating partner is (the smaller the value of the aggregate cost parameter C), the easier the coordination upon the perfect foresight equilibrium of the integrated economy. And conversely. For a strictly finite value of C_{H}, we also see that the likelihood of finding such an F-region integration partner decreases with the "degree of expectational instability" of the home region, as measured by $\frac{C_{\mathrm{H}}}{B}$. This can be seen immediately from the fact that:

$$\partial_B \left\{1 - \mu\left[\overline{\theta}_{\mathrm{F+H}}(B)\right]\right\} = -\frac{2}{\pi} \partial_B \overline{\theta}_{\mathrm{F+H}}(B) = \frac{\frac{2}{\pi}\left(\frac{C_{\mathrm{H}}}{B}\right)^2}{1 + C_{\mathrm{H}}^2 \left(3 + \frac{C_{\mathrm{H}}}{B}\right)^2} > 0$$

therefore, the higher the degree of expectational stability of the home economy (the higher the value of B, the lower the value of $\frac{C_{\mathrm{H}}}{B}$), the higher the likelihood of finding an economy in the F-class the integration with which yields strictly larger welfare gains than integration with an economy in the A-class.[49] Therefore:

49 Recall that regions in the A-class are those expectationally more stable than the home economy because they face the same aggregate demand (and therefore, the same value of the elasticity of demand B) but operate with higher costs: $\frac{1}{C_H} < \frac{1}{C_A}, \forall q$.

Proposition 10 *In the class of linear economies with equal maximal willignesses to pay:* (i) *If the purpose of Home economic integration is to maximize the welfare gains, relatively more performant regions will be preferred* (*F-regions will be preferred to A-regions*)*, and government restrictions will be most likely called for to coordinate upon the free trade equilibrium price.* (ii) *However, if the objective of Home economic integration is expectational coordination, relatively less performant regions will be preferred* (*A-regions will be preferred to F-regions*)*.*

Proof By construction. □

This is a surprising conclusion, the robustness of which remains to be ascertained.[50,51]

6 Conclusion

Inspired by Deardorff's (2002) exercise, we have departed from the standard competitive partial equilibrium framework substituting the central role of the Walrasian auctioneer as a coordinating institution by a truly decentralised coordinating device based on rational learning, perhaps endowing producers with more realistic abilities. Adopting the eductive learning viewpoint (Guesnerie 1992, 2000), we have shown how in a context where standard gains-from-trade exist, a free trade policy generates multiple (rationalizable) equilibria despite of the standard competitive equilibrium being unique. From an ex-ante viewpoint, as multiple equilibria cannot be probabilized, trade increases the uncertainty perceived by producers ("fear of globalisation"). We claim that this new rationale may explain producers' reluctance to remove trade barriers (or at least to prefer "gradualism" to an abrupt integration exercise, explaining the persistence).

A testable empirical implication is that free trade may actually lead to increased price dispersion rather than to convergence across regions (law of one price, in the aggregate, as illustrated in Fig. 5). This fact has been recently documented by Bergin and Glick (2005), Crucini et al. (2005), Engel (1999) or Engel and Rogers (2004), for the EU, within the US, and for the CUSTA-NAFTA trade integration experiences, respectively. An empirical test of the theory presented here would take advantage of the "buffer stock" theory of precautionary savings as applied to producers. If the announcement of a free-trade policy exacerbates the uncertainty producers foresee, theory would predict that non-exporting firms should endow excess balance sheet financial provisions relative to both own history (past average precautionary accumulation of

[50] What seems crucial for the argument to extend to non-linear schedules is the existence of a finite maximal willingness to pay for the good.

[51] A caveat is in order. When the PFE price is not the unique rationalizable expectations equilibrium price, the aggregate surplus need not be the appropriate evaluation criterion in welfare terms. The reason is that it is based on the difference in welfare terms between the two Nash equilibrium prices (autarkic and integration) disregarding whether they can be educed or not. A more appropriate criterion in welfare terms would necessitate of computing producers' welfare when the set of rationalizable expectations equilibria is not a singleton. A solution to this serious problem (selection among a continuum of rationalizable equilibria) is beyond the scope of the present work.

funds to cope with anticipated uncertainty) and to exporters (which already compete abroad and therefore do not fear foreign competition to the same extent).

Although a natural extension would be to relate the conditions for the eductive stability of a free trade equilibrium to the basic theorems of international trade, a first difficulty stems in recognizing that most of such trade theorems concern comparative statics questions in a general equilibrium set up. Yet, most of the conclusions on the eductive stability literature relate to partial equilibrium economies.[52] Hopefully the results presented here would stimulate further research along these lines.

Appendix 0

Proof of Proposition 6 Under the condition $\frac{A_n}{B_n} = \frac{A_{n'}}{B_{n'}} = \frac{A}{B}, \forall n, n' \in \mathbf{N}$ the anchorage assumption is given by $p_0 = \frac{A_\Sigma}{B_\Sigma} = \frac{A}{B}$. For parts (i), (ii) compute the limit $\lim_{\tau \to +\infty} p_\tau$ of the price sequence in Proposition 3 after replacing $\left(-\frac{C_\Sigma}{B_{n_0}}\right)$ by $\left(-\frac{C_\Sigma}{B_\Sigma}\right)$, and $\frac{A_{n_0}}{B_{n_0}}$ by $\frac{A_\Sigma}{B_\Sigma}$. To prove part (iii) notice that $D(p) = \sum_n D_n(p)$ implies that $D'(p) = \sum_n D'_n(p) \le 0$ by $D'_n(p) \le 0, \forall n$. Also, $S(p) = \sum_n S_n(p)$ implies that $S'(p) = \sum_n S'_n(p) > 0$ by $S'_n(p) > 0, \forall n$. The linearity of the regional demand and supply schedules implies that: $D'_n(p_1) = D'_n(p_2)$, $S'_n(p_1) = S'_n(p_2), \forall n$ and $\forall p_1, p_2 \in [0, p_0), \forall p_1, p_2 \in [p_0, +\infty),$. From part (i) in Proposition 2, $\left|\varphi'(p)\right| = \left|\frac{S'(p)}{D'(p)}\right| < 1, \forall p$. Expanding the sums and using the linearity, we can rewrite it as $\left|\varphi'(p)\right| = \left|\sum_n \frac{D'_n(p)}{D'(p)} \frac{S'_n(p)}{D'_n(p)}\right| = \left|\sum_n \alpha_n \varphi'_n(p)\right| < 1, \forall p$. Since $\forall n, \alpha_n \ge 0$, $\sum_n \alpha_n = 1$, the regional integration expectational stability condition is a convex combination of the autarkic expectational stability conditions. Therefore:

$$\min_n \left|\varphi'_n(p)\right| \le \left|\varphi'(p)\right| = \left|\sum_n \alpha_n \varphi'_n(p)\right| \le \max_n \left|\varphi'_n(p)\right|$$

implies that if the autarkically most unstable region is expectationally stable, so must the regional integration be:

$$\max_n \left|\varphi'_n(p)\right| < 1 \Longrightarrow \left|\varphi'(p)\right| < 1$$

That the converse is not true follows trivially from the convex combination set of inequalities above. □

Appendix 1

We completely characterize the learning dynamics of Proposition 7. The results are summarized in Table 1, and the definitions of the symbols immediately follow:

[52] General equilibrium applications of the eductive viewpoint are introduced in Calvo-Pardo and Guesnerie (2005).

Table 1 Summary of results of Proposition 7

C_Σ							
$>$	$[0, p_0]$	$[0, p_0]$	$[0, p_0]$	$[0, p_0]$	$[0, p_0]$	$[0, p_0]$	$\emptyset$
$= C_\Sigma^1$	$[0, p_0]$	$[0, p_0]$	$[0, p_0]$	$[0, p_0]$	$[0, p_0]$	$[0, p_0]$	$\emptyset$ $\emptyset$ $\emptyset$
$\geq$	$\{\overline{p}\}$	$\{\overline{p}\}\|_P$	$\{\overline{p}\}\|_P$	$\{\overline{p}\}\|_P$	$\{\overline{p}\}\|_P$	$\{\overline{p}\}\|_P$ $[0, p_0]$ $[0, p_0]$	$\emptyset$
$= C_\Sigma^0$	$\{\overline{p}\}$	$\{\overline{p}\}\|_P$	$\{\overline{p}\}\|_P$	$\{\overline{p}\}\|_P$	$\{\overline{p}\}\|_P$ $[0, p_0]$ $\left[\overline{p}_{c1}, \overline{p}_{c2}\right]$	$\left[\overline{p}_{c1}, \overline{p}_{c2}\right]$	$\emptyset$
$>$	$\{\overline{p}\}$	$\{\overline{p}\}$	$\{\overline{p}\}$	$\{\overline{p}\}$ $\{\overline{p}\}$ $\left[\overline{p}_{c1}, \overline{p}_{c2}\right]$	$\left[\overline{p}_{c1}, \overline{p}_{c2}\right]$	$\left[\overline{p}_{c1}, \overline{p}_{c2}\right]$	$\emptyset$
$= C_\Sigma^2$	$\{\overline{p}\}$	$\{\overline{p}\}$	$\{\overline{p}\}$ $\{\overline{p}\}$ $\left[\overline{p}_{c1}, \overline{p}_{c2}\right]\|$	$\left[\overline{p}_{c1}, \overline{p}_{c2}\right]\|$	$\left[\overline{p}_{c1}, \overline{p}_{c2}\right]\|$	$\left[\overline{p}_{c1}, \overline{p}_{c2}\right]\|$	$\emptyset$
$>$	$\{\overline{p}\}$	$\{\overline{p}\}$ $\{\overline{p}\}$ $\{\overline{p}\}$	$\{\overline{p}\}$	$\{\overline{p}\}$	$\{\overline{p}\}$	$\{\overline{p}\}$	$\emptyset$
0	$\emptyset$ $\emptyset$ $\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$
$\begin{pmatrix} C_\Sigma > \overline{C}_\Sigma \\ C_\Sigma = \overline{C}_\Sigma \\ C_\Sigma < \overline{C}_\Sigma \end{pmatrix}$	0	$<$	$= C_\Sigma^2$	$<$	$= C_\Sigma^0$	$\leq$	$C_\Sigma^1 = \overline{C}_\Sigma$

The contents, following the results of Proposition 2, indicate the set of rationalizable-expectations equilibria, where the exogenous price restriction p_0 is embedded in the model (it is the maximum willingness to pay of the integrated economy demand):

- "$[0, p_0]$" means that the set of rationalizable expectations equilibria usually contains the whole price domain $[0, p_0]$. As farmers learn nothing, $\overline{p}$ is not an SREE;
- "$\left[\overline{p}_{c1}, \overline{p}_{c2}\right]$" means that the set of rationalizable prices is the whole segment $\left[\overline{p}_{c1}, \overline{p}_{c2}\right] \supset \overline{p}$, where $p_{c2} = \varphi(p_{c1}), \varphi^2(p_{ct}) = p_{ct}, t = 1, 2$ define cycles of order two of the cobweb function. For some parameterizations, the embedded price restriction p_0 can belong to the set $\left[\overline{p}_{c1}, \overline{p}_{c2}\right]$. Then, an exogenous price invertevention is called for restricting p_0 to be out of it: $p_0 \notin \left[\overline{p}_{c1}, \overline{p}_{c2}\right]$, denoting such a requirement by "$\left[\overline{p}_{c1}, \overline{p}_{c2}\right]|$", meaning "$\left[\overline{p}_{c1}, \overline{p}_{c2}\right]$ is the set of rationalizable prices conditional to that price restriction".
- "$\{\overline{p}\}$" means that the only rationalizable-expectations price equilibrium is the PFE $\overline{p}$, and $\overline{p}$ is an SREE.
- "$\{\overline{p}\}|_P$" means that the only rationalizable-expectations price equilibrium is the PFE $\overline{p}$ conditional to an exogenous price intervention restricting the natural one p_0 to be in the basin of attraction[53] of $\overline{p}$, $P(\overline{p}) = \left(\overline{p}_{c1}, \overline{p}_{c2}\right) \setminus \{\overline{p}\}$, and $\overline{p}$ is an "SREE conditional to that price restriction".

[53] The basin of attraction $P(\overline{p})$ of a given equilibrium price $\overline{p}$ is composed by the union of all the $p_0 \neq \overline{p}$ s.t. $\lim_{\tau \longrightarrow +\infty} \varphi^\tau(p_0) = \overline{p}$.

As the characterization of $\varphi^2(\cdot)$ depends on $p^{i\prime}, p^i$ the learning dynamics will ultimately depend on whether $C_\Sigma \gtreqless \overline{C}_\Sigma$, since from the definitions of $p^{i\prime}, p^i$ and their properties we know that they depend on the value of the aggregate cost parameter C_Σ. In principle, $C_\Sigma \in \mathbb{R}_{++}$. We are going to divide the C_Σ-parameter space in four regions according to the following definitions of C_Σ^0, C_Σ^1 and C_Σ^2 satisfying:

$$+\infty > C_\Sigma^1 \geq C_\Sigma^0 > C_\Sigma^2 > 0$$

With $C_\Sigma^1 \equiv B_\Sigma$ characterizing the limit value of the aggregate cost parameter above which the PFE price $\overline{p}$ becomes eductively unstable; $C_\Sigma^0 \equiv B_2\left[1+\frac{A_1}{A_2}\right]$ satisfies $\lim_{\frac{A_2}{B_2}\to\frac{A_1}{B_1}} C_\Sigma^1 = C_\Sigma^0$ so that the whole region $\left[C_\Sigma^0, C_\Sigma^1\right]$ collapses into that value $\left\{C_\Sigma^0\right\}$. Finally $C_\Sigma^2 \equiv B_2$ characterizes the limit value of the aggregate cost parameter below which the PFE price $\overline{p}$ becomes eductively stable, i.e. if $C_\Sigma^2 > C_\Sigma > 0 \Longrightarrow \overline{p}$ is globally an SREE. Since the difference in the maximal willingnesses to pay is measured by the parameter $\overline{C}_\Sigma$, its range of variation will also be constrained to the regions for C_Σ.[54] We allow the possibility that $0 = \overline{C}_\Sigma$ because it corresponds to the case studied in Proposition 6.

Appendix 2

Proof of Proposition 8 Since $\exists n, n' \in \mathbf{N} : \frac{A_n}{B_n} \neq \frac{A_{n'}}{B_{n'}}$, assume that there exists a region the consumers of which will not be able to afford the consumption of the crop at the prevailing PFE price $\overline{p}$, we have that:

$$\sum_{n:\overline{p}\leq p_0^n} D_n'(\overline{p}) \geq \sum_n D_n'(\overline{p}) \Longrightarrow$$

$$\frac{\sum_n D_n'(\overline{p})}{\sum_{n:\overline{p}\leq p_0^n} D_n'(\overline{p})}\left[\sum_n \alpha_n \varphi_n'\left(\overline{p}_n\right)\right] \leq \frac{\sum_n S_n'(\overline{p})}{\sum_n D_n'(\overline{p})} = \sum_n \alpha_n \varphi_n'\left(\overline{p}_n\right)$$

Taking absolute values on both sides:

$$\left|\varphi'(\overline{p})\right| \geq \left|\sum_n \alpha_n \varphi_n'\left(\overline{p}_n\right)\right|$$

So that when differences in the maximal willingness to pay for the crop exist (Left-hand side), the PFE price is "more unstable" than when they do not exist (Right-hand

[54] With the exception introduced by property 3 of the (second) intersecting price $p^{i\prime}$ according to which $0 \leq \overline{C}_\Sigma < C_\Sigma^1$. Details are in Appendix 2.

side Proposition 6). But we can measure by how much, since:

$$\left|\varphi'\left(\overline{p}\right)\right| < 1 \Longleftrightarrow \left|\sum_n \alpha_n \varphi_n'\left(\overline{p}_n\right)\right| < \frac{\sum_{n:\overline{p}\leq p_0^n} D_n'(\overline{p})}{\sum_n D_n'(\overline{p})} \equiv \frac{1}{\varkappa_{\{n:\overline{p}\leq p_0^n\}}}.$$

With $\varkappa_{\{n:\overline{p}\leq p_0^n\}} \geq 1$, taking value 1 when the integration equilibrium price $\overline{p}$ is low enough so that the consumers of all the integrating regions can afford to pay it (the situation in Proposition 6): i.e. $\sum_{n:\overline{p}\leq p_0^n} D_n'(\overline{p}) = \sum_n D_n'(\overline{p})$. Then the conditions of Proposition 6 are strengthened to:

$$\varkappa_{\{n:\overline{p}\leq p_0^n\}} \min_n \left|\varphi_n'\left(\overline{p}_n\right)\right| \leq \left|\varphi'\left(\overline{p}\right)\right| \leq \varkappa_{\{n:\overline{p}\leq p_0^n\}} \max_n \left|\varphi_n'\left(\overline{p}_n\right)\right|.$$

Meaning that even if all autarkic price equilibria are expectationally stable, so that $\max_n \left|\varphi_n'\left(\overline{p}_n\right)\right| < 1$, the PFE price $\overline{p}$ can fail to be so whenever:

$$\varkappa_{\{n:\overline{p}\leq p_0^n\}} > \frac{1}{\max\limits_n \left|\varphi_n'\left(\overline{p}_n\right)\right|} \Longrightarrow \left|\varphi'\left(\overline{p}\right)\right| > \max_n \left|\varphi_n'\left(\overline{p}_n\right)\right|,$$

i.e. whenever there are sufficient economies the consumers of which cannot afford to pay the international price for the crop. The smaller the set of the economies in which consumers demand the crop at the international price $\left\{n : \overline{p} \leq p_0^n\right\}$, the smaller the elasticity of the integration aggregate demand, the larger the value of $\varkappa_{\{n:\overline{p}\leq p_0^n\}}$ above one, and the more likely becomes the above inequality. □

Proof of Proposition 9 First, if there are no differences in the maximal willingnesses to pay across regions, $\varkappa_{\{n:\overline{p}\leq p_0^n\}} = 1$ and $\varphi'\left(\overline{p}\right) = \sum_m \alpha_m \varphi_m'\left(\overline{p}\right)$. Although for non-linear economies $\varphi_m'\left(\overline{p}\right) \neq \varphi_m'\left(\overline{p}_m\right)$ since

$$\varphi_m'\left(\overline{p}\right) = \frac{D_m'\left(\overline{p}_m\right)}{D_m'\left(\overline{p}\right)} \frac{S_m'\left(\overline{p}\right)}{S_m'\left(\overline{p}_n\right)} \varphi_m'\left(\overline{p}_m\right)$$

we can rather expand $\varphi_m'(\cdot)$ as:

$$\varphi_m'\left(\overline{p}\right) = \varphi_m'\left(\overline{p}_m\right) + \left(\overline{p} - \overline{p}_m\right) \int_0^1 \varphi_m''\left[\overline{p}_m + \zeta\left(\overline{p} - \overline{p}_m\right)\right] d\zeta$$

Which plugged into $\varphi'\left(\overline{p}\right)$ yields:

$$\varphi'\left(\overline{p}\right) = \sum_m \alpha_m \varphi_m'\left(\overline{p}_m\right) + \underbrace{\sum_m \alpha_m \left(\overline{p} - \overline{p}_m\right) \int_0^1 \varphi_m''\left[\overline{p}_m + \zeta\left(\overline{p} - \overline{p}_m\right)\right] d\zeta}_{\equiv R \gtrless 0}$$

Then $\varphi'(\overline{p}) - R = \sum_m \alpha_m \varphi'_m(\overline{p}_m)$, which is a convex combination of the autarkic stability conditions. Therefore, taking absolute values on both sides:

$$\min_m \left|\varphi'_m(\overline{p}_m)\right| \le \left|\varphi'(\overline{p}) - R\right| \le \max_m \left|\varphi'_m(\overline{p}_m)\right|$$

Using the property that $\left|\varphi'(\overline{p}) - R\right| \ge \left|\left|\varphi'(\overline{p})\right| - |R|\right|$ and adding $+|R|$ to both sides of the second inequality in the above expression, we obtain:

$$\left|\varphi'(\overline{p})\right| = \left|\left|\varphi'(\overline{p})\right| - |R| + |R|\right| \le \left|\left|\varphi'(\overline{p})\right| - |R|\right| + |R| \le \max_m \left|\varphi'_m(\overline{p}_m)\right| + |R|$$

Reaching the desired conclusion, for even if $\max_m \left|\varphi'_m(\overline{p}_m)\right| < 1$, so that all autarkic integrating economies are expectationally stable, the regional integration of them need not because $\max_m \left|\varphi'_m(\overline{p}_m)\right| \le \max_m \left|\varphi'_m(\overline{p}_m)\right| + |R|$ and it can happen that $\left|\varphi'(\overline{p})\right| > \max_m \left|\varphi'_m(\overline{p}_m)\right|$ even if $\max_m \left|\varphi'_m(\overline{p}_m)\right| < 1$ (even without differences in the maximal willingnesses to pay across regions). Finally, notice that for economies in the linear class **N** of proposition 6, $R = 0$ so that this proposition extends the results obtained there. But as well, notice that even in the non-linear case it can happen that $R = 0$, as it is the case when the integrating economies are identical (Proposition 9 above). □

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