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Rethinking Ricardo's Principle of Comparative Advantage

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Rethinking Ricardo's Principle of Comparative Advantage

The principle of comparative advantage has long been at the foundation of a wide range of economic models. In the new evolving economy, with the conventional firm-centric view of value creation rapidly losing its relevance, the vision of this principle has weakened. We provide a framework, with co-creation experience embedded at the core, to align economic thinking on the principle of comparative advantage. We show how patterns of specialization and the resultant gains from trade, within or across borders, must be sensitive to co-creation experiences. In particular, an individual's experience from co-creation is at the foundation of what we posit as the principle of *co-creation* comparative advantage.

"Ricardo was the greatest mind that found economics worthy of its powers." *Roy Harrod* (1951)

1. Introduction

The Principle of Comparative Advantage was the quick pick, from the most celebrated of economic theories, when Paul Samuelson was challenged to identify one law of economics that is both true and non-trivial. Yet, as Paul Krugman questions, "Why is it virtually impossible to get a discussion of comparative advantage, not only onto newspaper op-ed pages, but even into magazines that cheerfully publish long discussions of the work of Jacques Derrida?" The widely used Principle, originally proposed a couple of centuries back by David Ricardo and subsequently reformulated by neoclassical economists in ways that fit into their frame of marginal analyses, has provided the basis for a large body of established economic models.[1] For instance, much work on

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[1] Ruffin (2002) offered a thorough historical account engaging careful introspection and a logical re-examination of Ricardo's discovery of the principle of comparative advantage, as well as thought-provoking analyses of later

international trade continues to glorify this principle by illustrating gains from trade that are attributable exclusively to specialization in production along the lines of comparative advantage.[2] A variety of adaptations of this principle, identifying sources of gains from trade due to asymmetries ranging from countries to firms, have gained significant mileage.[3]

However, conventional formulations of Ricardo's principle of comparative advantage, which originally took a cue from Adam Smith's (1776) magnum opus *Wealth of Nations* [4], have increasingly been drawing serious skepticism. While the "nirvana approach" [5] revolves around portraying the market as an interface for firms and consumers to engage exclusively in exchange of commodities, we believe that much of the skepticism can be addressed by removing the obsolete assignment of distinct roles to firms and consumers which has left "Ricardo's disciples befuddled" and suggests "the theory needs updating".[6] As Chakrabarti and Ramaswamy (2014) have shown, conventional economic thinking leaves out a vast potential of *co-creation surplus* by simply ignoring the fact that an enterprise can and does, even more so in the modern Internetworked age, release its resource constraints by investing in engagement platforms that co-create value by enhancing the diverse experience of individuals. This is evident with the advent of the web, mobile

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reconstructions of the principle that have often led to "misunderstandings" stemming from "a confused tangle of claims of priority, error, incompleteness, and attribution".

[2] See Lind (2003).

[3] See Schumacher (2013) for a recent assessment of this vast body of literature that has developed since Sraffa and Dobb (1952).

[4] Chipman's (1965) account, which attributed the first complete statement of Ricardo's principle to Mill (1844), was reflective of the sentiment contained in a historic remark by Torrens (1815): "Adam Smith is, with the single exception of Ricardo, our highest authority on economical questions."

[5] The expression "nirvana approach" was used by Harold Demsetz, as early as 1969, to characterize the typical fallacy inherent in conventional economic thinking when comparing an imperfect existing arrangement to a hypothetical idealized system.

[6] *Source:* "Revisiting Ricardo", *The Economist*, August 23, 2014.

technologies of expression, communication, and information, enabling value to be *created jointly* by the individual and the firm, in the new co-creation economy.[7]

Ricardo's [8] original exposition of the principle of comparative advantage was in terms of 2 countries (England and Portugal), which could make 2 goods (cloth and wine) using only 1 factor (labor) of production, as shown in Table 1.[9] In this 2x2x1 world, production of each good required a fixed amount of labor per unit of output (as summarized in table 1 below) and labor could move freely between industries but not between countries.

Table 1: Unit Labor Requirements for Cloth and Wine

	Cloth	Wine
England	100	120
Portugal	90	80

Conventional comparative advantage would correspond to a cross-country comparison of the ratio of unit labor requirements (i.e. how many workers each country needed to make a unit of each good). England would have needed 100 laborers to produce the same amount of cloth that Portugal could produce with 90 laborers, in Ricardo's world, while Portugal would have needed 80 laborers to produce the same amount of wine that England could produce using 120 laborers.

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[7] Note that co-creation is not confined to endogenous product creation that is driven by close interaction with consumer experiences, but rather endogenous and joint human experience creation that is driven by close individual desirable interactions. See Prahalad and Ramaswamy (2000, 2004a, 2004b), Ramaswamy and Gouillart (2010a, 2010b), Leavy (2013, 2014) and Ramaswamy and Ozcan (2014).

[8] See Ricardo (1817).

[9] Haberler (1930) was among the first to visualize that opportunity cost, at the margin, was at the heart of the principle of comparative advantage.

Ricardo then demonstrated how it could be to the advantage of both nations to follow his principle of comparative advantage if each were to specialize and trade: exchanging 1 unit of cloth for 1 unit of wine, for illustration, would allow England to import each unit of wine with the effort of only 100 workers (instead of 120) and Portugal to obtain import each unit of cloth with the effort of only 80 workers (instead of 90).

Beyond these "four magic numbers" [10], in a 2x2x1 Ricardian world, $\frac{p_g}{p_{-g}} \in \left(\frac{a_g^c}{a_{-g}^c}, \frac{a_g^{-c}}{a_{-g}^{-c}} \right)$ would yield mutual gains from trade between countries c and $-c$, through complete specialization in the production of goods g and $-g$, respectively, where a_g^c is the unit labor requirement for good g in country c and $\frac{p_g}{p_{-g}}$ is the price of good g relative to $-g$ in an Integrated World Equilibrium (IWE) which each country would face with free and frictionless trade allowing perfect mobility of goods. An IWE would yield gains from trade for country c, through complete specialization in the production of good g, since

$$p_g \left(\frac{1}{a_g^c} \right) \left(\frac{1}{p_{-g}} \right) > \frac{1}{a_{-g}^c}$$

which compares the quantity of the other good $(-g)$ country c can purchase from the proceeds of what it can produce of good g using one unit of labor, with what it can produce of good $-g$ using the same unit of labor. Analogously, the same IWE would yield gains from trade for c's trading partner $(-c)$, through complete specialization in the production of good $-g$, since

$$p_{-g} \left(\frac{1}{a_{-g}^{-c}} \right) \left(\frac{1}{p_g} \right) > \frac{1}{a_g^{-c}}$$

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[10] See Samuelson (1972).

This laid the foundation for mutual benefits from specialization in production and consequent trade along the lines of comparative advantage that conventional economic thinking claims as inevitable in Ricardo's world as he is construed to have envisaged an increase in the "amount and variety of the objects on which revenue may be expended."

2. Rethinking Ricardo

Let us now pause to think: Would David Ricardo have formulated the principle of comparative advantage any differently in the new co-creation economy? It is important to clarify, at the outset that, in posing this question, we are not challenging the view that trade can lead to mutually beneficial gains. Instead, we are questioning the relevance of keeping the principle of comparative advantage tied to an obsolete theory of value creation, restricted to the relational property of goods and services (Ramaswamy and Ozcan 2014), the deficiencies of which are becoming increasingly apparent in the context of value generated as a function of co-creation experiences (Chakrabarti and Ramaswamy 2014). This conspicuous neglect inevitably attracts more skepticism about the relevance of the principle of comparative advantage than it deserves.

Following Chakrabarti and Ramaswamy (2014), consider the element of value as generated from co-creation experiences resulting from individual interactions through engagement platforms. Suppose V_i is the value derived by an individual i as a function of C_{ij}, representing the vector of individual i's co-creation experiences on engagement platform j, as well as on the conventional vector of i's actions (A_i), others' actions (A_{-i}), and controls (k_i) that entail all else affecting the value i derives:

$$V_i = V_i\big(C_{ij}, A_i, A_{-i}, k_i\big).$$

The arguments of the value function $V_i(.)$ are not only sufficient to capture the standard economic role of own actions and externalities but incorporates co-creation experience as a motivation for individual economic behavior. Individual i's co-creation experience on engagement platform j can then be expressed as:

$$C_{ij} = C_{ij}\big(R_{ij}, R_{-ij}, T_{ij}, T_{-ij}, , A_i, A_{-i}, k_i\big),$$

where T_{ij} and T_{-ij} represent time and R_{ij} and R_{-ij} represent resources invested by individual i and others $-i$ (including, though not necessarily limited to, those on platform j), respectively, in the engagement specific to platform j.

Now consider re-constructing Ricardo's example[11] with the cognition that value need not be constricted to production possibilities of goods (or, for that matter, production-sharing arrangements in occupations and/or tasks) but can be expanded through co-creation experiences via engagement platforms. It is important to note that our construct of co-creation experiences, goes beyond the co-production of a good or service exchange process by its end user (popularly known as prosumption). While any distinction between the conventional consumer and a prosumer can be attributed to the latter generating use value by contributing to the production of an artifact or service exchange entering her own consumption, any distinction between the conventional producer and a prosumer can be attributed to the former generating only trade (exchange) value. Value generated through co-creation experiences spans a larger space of *joint agency*

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[11] Although Ricardo's world may appear incomplete, in this millennium, his example provides a natural benchmark due to the simplicity with which it allows us to draw a comparison between the real and the counterfactual.

(Ramaswamy and Ozcan 2014) than does prosumption, in comparison, since the former arises from co-creativity than mere transfer/doing of work to/by the consumer (Toffler 2013).

Consider a website offering a platform for individuals to design an artifact, which can potentially improve the quality and/or add to the variety of the artifacts produced. The designing of an artifact (by an individual on a platform), however, need not necessarily lead to an artifact being produced (to generate exchange value) and/or used (to derive use value). Further, value is enacted through interaction and embodied in agential (i.e. pertaining to the capacity, condition, or state of acting) experience (Ramaswamy and Ozcan 2014). An individual, who neither contributes to the production of an artifact nor uses it, can still derive value through her embodied agential experience of engagement.

Formally, a conventional segregation of a typical producer (p) from a typical consumer (c) would stylize a scenario where the objective of each individual (i), in isolation, boils down to the choice of actions (A_i) in a way that maximizes

$$V_i = V_i(A_i, A_{-i}, k_i) \qquad i = p, c$$

Let A_{ia} be the set of actions affecting the production of artifact a that supports a use value of $V_{ca} \in V_c$ and an exchange value of $V_{pa} \in V_p$. Thus, use value can be generated through prosumption if and only if $A_{ia} \cap A_c \neq \emptyset$. In sharp contrast, value can be generated through co-creation experiences with or without $A_{ia} \cap A_c$ being empty. To fix our ideas, through illustration, let us

then look at the possibility of *co-creation experiences* through smart phones[12] in an otherwise Ricardian world replacing England by China, as shown in Table 2.

Table 2: Unit Labor Requirements for Cloth, Wine, and Smart Phone Co-Creation Experiences

	Cloth	Smart Phone Co-Creation Experiences	Wine
China	100	110	120
Portugal	90	85	80

The economics of co-creation experiences encompasses both the value generated through co-creation experiences in infusing a "producer's" activities via co-creation engagement platforms (e.g., Apple's opening up of smart phone application development), as well as embedding of co-creation engagement platforms by a "producer" in a "consumer's" activities (e.g., Apple's iPhone as a platform for a consumer to monitor diabetes together with a company such as Johnson & Johnson). It is important to underscore that the vision of the emerging field of Co-creation Experience Economics reaches beyond an enterprise (e.g., Apple) "selling the experience" of using an artifact (e.g smart phone) in conventional market trade (exchange). Further, it is important to recognize that the value through co-creation experiences of using a smart phone as an engagement platform of which the artifact is but a component (in an assemblage of related artifacts, interfaces, processes, and persons) is distinct from an enterprise (Apple) selling the goods experience of using the same artifact. Limiting attention to selling an experience (from the use of an artifact) would

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[12] We thank Michele Tertilt for motivating this example. While it would not be a stretch to conceptualize co-creation experiences on engagement platforms involving Wine and/or Cloth, for ease of comparison, we choose to retain Ricardo's characterization of these goods.

conspicuously overlook the essence of co-creation experiences that transcend traditional trading between an artificially differentiated consumer and producer, which remains valid only at the point of market trade (exchange), but is of no relevance when individuals choose to share the same engagement platform with or without an eventual exchange of an artifact. As such, the implications of Co-creation Experience for Economics, in general, and the Principle of Comparative Advantage, in particular, cannot be conceptualized through considerations of conventional production functions (or utility functions) which have been reduced to tools that isolate distinctive roles for the consumer from the firm and, in doing so, have blurred the vision of the real co-creation economy as it is evolving.

Consequently, individual co-creation experiences are generated on a *continuum*, through engagement platforms embedded in the "producer's" activities or a "consumer's" activities (in traditional economic parlance) that are inextricably interrelated in a *joint agential space of co-creation* (Ramaswamy and Ozcan 2014). In comparison, existing extensions of the Ricardian principle would involve constructing a chain of comparative advantage by sorting the productivity of Chinese labor relative to Portugese labor in the production of Cloth, Smart Phones, and Wine respectively: [13]

$$\underset{Cloth}{\frac{90}{100}} \quad > \quad \underset{Smart\ Phone}{\frac{85}{110}} \quad > \quad \underset{Wine}{\frac{80}{120}}$$

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[13] See Neary (2003, 2007) for recent innovations in identifying patterns of specializaton and trade, consistent with the Dornbusch, Fischer, Samuelson (1977) extension of the Ricardian principle of comparative advantage, in a general oligopolistic equilibrium.

Under free and frictionless trade, the hourly wage (ω) in China relative to Portugal would be used to break this chain by identifying the efficiency gains from specialization in production. For instance, $\omega = 0.8$ would suggest that China gains from specializing in the production of Cloth, and Portugal gains from specializing in the production of Smart Phones and Wine. Does this pattern of specialization exhaust all possible gains for China and Portugal? To answer this question, in what follows, we embrace co-creation experiences in economics recognizing that value can be, and *is* being generated in the new evolving economy, on engagement platforms that are not limited to producing *more* of a good.

3. The Principle of Co-Creation Comparative Advantage

Now visualize the vast potential of co-creation surplus[14] that conventional economic thinking leaves out by simply ignoring the fact that an enterprise can and does, even more so in the modern Internetworked age, release its resource constraints by investing in engagement platforms that co-create value by enhancing the diverse experience of individuals. Conventional economic thinking would introspect that a typical individual i chooses its actions A_i in a way that maximizes V_i, ceteris paribus. This apparently draws the boundaries of the market where the goal of each firm, given its own resource constraints, is reduced to a) the maximum extraction of surplus from individual consumers, and b) the minimum expense of the extracted surplus on individual workers, that specific market structures allow.

In a world of co-creation, the objective of the enterprise(s) providing platform j is to

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[14] See Chakrabarti and Ramaswamy (2014).

$$\text{Maximize:} \quad V_j = V_j\big(C_{ji}, C_{-ji}, A_j, A_{-j}, c_j\big)$$
$$\{R_{ji}, T_{ji}, a_j\}$$
$$\text{subject to} \quad \overline{T}_j = \sum_i T_{ji} + T_j(R_{ji})$$

while each individual's objective is to

$$\text{Maximize:} \quad V_i = V_i\big(C_{ij}, C_{-ij}, A_i, A_{-i}, c_i\big)$$
$$\{R_{ij}, T_{ij}, a_i\}$$
$$\text{subject to} \quad \overline{T}_\iota = \sum_j T_{ij} + T_i(R_{ij})$$

where C_{ji} is the vector of co-creation experiences of all individuals engaged on platform j; C_{-ji} is

the vector of co-creation experiences of all individuals engaged on platforms other than j; A_j is the

vector of actions of the enterprise(s) providing platform j, A_{-j} is the vector of others' actions; and

c_j is the vector of controls entailing all else affecting the value generated on platform j. The

singular binding constraint is imposed by the arrow of time $T = \{\overline{T}_\iota, \overline{T}_j\}$ on the optimal choice of

any individual or enterprise (participant) with a finite horizon, where $\overline{T}_\iota$ represents the vector time

horizons of individuals and $\overline{T}_j$ represents the vector time horizons of enterprises, within which T_{ji}

represents time and R_{ji} represents resources invested, in the co-creation experiences of

participating individuals i, by the enterprise(s) providing platform j; $T_i(R_{ij})$ represents the time

invested by individual in acquiring resources R_{ij}; and $T_j(R_{ji})$ represents the time invested by the

enterprise(s) providing platform j in acquiring resources R_{ji}. This optimization exercise yields a

set of co-creation possibilities $C^g(T) = \begin{bmatrix} C_{ij}^g & C_{ji}^g \end{bmatrix}$, $\forall g$. It follows, for any individual i located in

country c, $\frac{p_g}{p_{-g}} \in \left(\frac{a_g^c}{a_{-g}^c}, \frac{a_g^{-c}}{a_{-g}^{-c}} \right)$ would not suffice for gains from specialization in the production of g

unless

$$V_i\left(p_g\left(\frac{1}{a_g^c}\right)\left(\frac{1}{p_{-g}}\right)\right) > V_i\left(\frac{1}{a_{-g}^c}, C_{ij}^{-g}\left(\frac{1}{a_{-g}^c}\right)\right)$$

Analogously, for any individual $-i$ located in country $-c$, $\frac{p_g}{p_{-g}} \in \left(\frac{a_g^c}{a_{-g}^c}, \frac{a_g^{-c}}{a_{-g}^{-c}}\right)$ would not suffice for

gains from specialization in the production of $-g$ unless

$$V_{-i}\left(p_{-g}\left(\frac{1}{a_{-g}^{-c}}\right)\left(\frac{1}{p_g}\right)\right) > V_{-i}\left(\frac{1}{a_g^{-c}}, C_{-ij}^{g}\left(\frac{1}{a_g^{-c}}\right)\right)$$

This leads to the conception of our Principle of Co-Creation Comparative Advantage: an IWE would support mutual gains from trade for countries c and $-c$, irrespective of the location of the engagement platform j, through complete specialization in the production of goods g and $-g$, respectively, *iff*

$$\sum_{i \subset c} V_i\left(p_g\left(\frac{1}{a_g^c}\right)\left(\frac{1}{p_{-g}}\right)\right) > \sum_{i \subset c} V_i\left(\frac{1}{a_{-g}^c}, C_{ij}^{-g}\left(\frac{1}{a_{-g}^c}\right)\right)$$

$$\sum_{-i \subset -c} V_{-i}\left(p_{-g}\left(\frac{1}{a_{-g}^{-c}}\right)\left(\frac{1}{p_g}\right)\right) > \sum_{-i \subset -c} V_{-i}\left(\frac{1}{a_g^{-c}}, C_{-ij}^{g}\left(\frac{1}{a_g^{-c}}\right)\right)$$

The Principle of Co-Creation Comparative Advantage not only embeds co-creation in Ricardo's vision of a rise in *"the sum of enjoyments"* through an increase in the "amount and variety of the objects on which revenue may be expended", but also identifies distinct possibilities where mutual benefits from specialization in the production of goods g and $-g$ (in line with the conventional concept of comparative advantage) will not be ensured by $\frac{p_g}{p_{-g}} \in \left(\frac{a_g^c}{a_{-g}^c}, \frac{a_g^{-c}}{a_{-g}^{-c}}\right)$. This Principle, cognizant of the fact that value is jointly created through individuated co-creation

experiences, thus expands our vision to identify mutual gains from specialization, as well as diversification, through co-creation.

No less critical, for a complete understanding of this Principle of Co-Creation Comparative Advantage, is the observation that deviations from conventional lines of specialization leave sufficient room for gains from trade through co-creation. An individual i located in country c gains, from co-creation on the engagement platform engagement platform j of $-g$ as long as

$$V_i\left(\frac{1}{a^c_{-g}}, C_{ij}^{-g}\left(\frac{1}{a^c_{-g}}\right)\right) > V_i\left(p_g\left(\frac{1}{a^c_g}\right)\left(\frac{1}{p_{-g}}\right)\right)$$

and
$$V_i\left(p_{-g}\left(\frac{1}{a^c_{-g}}\right)\left(\frac{1}{p_g}\right)\right) > V_i\left(\frac{1}{a^c_g}, C_{ij}^{g}\left(\frac{1}{a^c_g}\right)\right)$$

An individual $-i$ located in country $-c$ gains from co-creation on the engagement platform j of g as long as

$$V_{-i}\left(\frac{1}{a^{-c}_g}, C_{-ij}^{g}\left(\frac{1}{a^{-c}_g}\right)\right) > V_{-i}\left(p_{-g}\left(\frac{1}{a^{-c}_{-g}}\right)\left(\frac{1}{p_g}\right)\right)$$

and
$$V_{-i}\left(p_g\left(\frac{1}{a^{-c}_g}\right)\left(\frac{1}{p_{-g}}\right)\right) > V_{-i}\left(\frac{1}{a^{-c}_{-g}}, C_{ij}^{-g}\left(\frac{1}{a^{-c}_{-g}}\right)\right)$$

Consequently, contrary to a conventional interpretation of the principle of comparative advantage, an IWE relative price $\frac{p_g}{p_{-g}} \in \left(\frac{a^c_g}{a^c_{-g}}, \frac{a^{-c}_g}{a^{-c}_{-g}}\right)$ would support mutual gains from trade through co-creation, through complete specialization through co-creation of country c in $-g$ and country $-c$ in g, as long as

$$\sum_{i \subset c} V_i\left(\frac{1}{a^c_{-g}}, C_{ij}^{-g}\left(\frac{1}{a^c_{-g}}\right)\right) > \sum_{i \subset c} V_i\left(p_g\left(\frac{1}{a^c_g}\right)\left(\frac{1}{p_{-g}}\right)\right)$$

$$\sum_{i\subset c} V_i \left(p_{-g} \left(\frac{1}{a_{-g}^c} \right) \left(\frac{1}{p_g} \right) \right) > \sum_{i\subset c} V_i \left(\frac{1}{a_g^c}, C_{ij}^g \left(\frac{1}{a_g^c} \right) \right)$$

$$\sum_{-i\subset -c} V_{-i} \left(\frac{1}{a_g^{-c}}, C_{-ij}^g \left(\frac{1}{a_g^{-c}} \right) \right) > \sum_{-i\subset -c} V_{-i} \left(p_{-g} \left(\frac{1}{a_{-g}^{-c}} \right) \left(\frac{1}{p_g} \right) \right)$$

and
$$\sum_{-i\subset -c} V_{-i} \left(p_g \left(\frac{1}{a_g^{-c}} \right) \left(\frac{1}{p_{-g}} \right) \right) > \sum_{-i\subset -c} V_{-i} \left(\frac{1}{a_{-g}^{-c}}, C_{ij}^{-g} \left(\frac{1}{a_{-g}^{-c}} \right) \right)$$

Country c gains from specializing in the production of good $-g$ while the other country stands to gain from diversification through co-creation *iff*

$$\sum_{i\subset c} V_i \left(\frac{1}{a_{-g}^c}, C_{ij}^{-g} \left(\frac{1}{a_{-g}^c} \right) \right) > \sum_{i\subset c} V_i \left(p_g \left(\frac{1}{a_g^c} \right) \left(\frac{1}{p_{-g}} \right) \right)$$

$$\sum_{i\subset c} V_i \left(p_{-g} \left(\frac{1}{a_{-g}^c} \right) \left(\frac{1}{p_g} \right) \right) > \sum_{i\subset c} V_i \left(\frac{1}{a_g^c}, C_{ij}^g \left(\frac{1}{a_g^c} \right) \right)$$

$$\sum_{-i\subset -c} V_{-i} \left(\frac{1}{a_g^{-c}}, C_{-ij}^g \left(\frac{1}{a_g^{-c}} \right) \right) > \sum_{-i\subset -c} V_{-i} \left(p_{-g} \left(\frac{1}{a_{-g}^{-c}} \right) \left(\frac{1}{p_g} \right) \right)$$

and
$$\sum_{-i\subset -c} V_{-i} \left(\frac{1}{a_{-g}^{-c}}, C_{ij}^{-g} \left(\frac{1}{a_{-g}^{-c}} \right) \right) > \sum_{-i\subset -c} V_{-i} \left(p_g \left(\frac{1}{a_g^{-c}} \right) \left(\frac{1}{p_{-g}} \right) \right)$$

Analogously, country c stands to gain from diversification through co-creation while the other country gains from specializing in the production of good g *iff*

$$\sum_{i\subset c} V_i \left(\frac{1}{a_{-g}^c}, C_{ij}^{-g} \left(\frac{1}{a_{-g}^c} \right) \right) > \sum_{i\subset c} V_i \left(p_g \left(\frac{1}{a_g^c} \right) \left(\frac{1}{p_{-g}} \right) \right)$$

$$\sum_{i\subset c} V_i \left(\frac{1}{a_g^c}, C_{ij}^g \left(\frac{1}{a_g^c} \right) \right) > \sum_{i\subset c} V_i \left(p_{-g} \left(\frac{1}{a_{-g}^c} \right) \left(\frac{1}{p_g} \right) \right)$$

$$\sum_{-i\subset -c} V_{-i} \left(\frac{1}{a_g^{-c}}, C_{-ij}^g \left(\frac{1}{a_g^{-c}} \right) \right) > \sum_{-i\subset -c} V_{-i} \left(p_{-g} \left(\frac{1}{a_{-g}^{-c}} \right) \left(\frac{1}{p_g} \right) \right)$$

and
$$\sum_{-i \subset -c} V_{-i} \left(p_g \left(\frac{1}{a_g^{-c}} \right) \left(\frac{1}{p_{-g}} \right) \right) > \sum_{-i \subset -c} V_{-i} \left(\frac{1}{a_{-g}^{-c}}, C_{ij}^{-g} \left(\frac{1}{a_{-g}^{-c}} \right) \right)$$

Finally, both countries gain from diversification through co-creation *iff*

$$\sum_{i \subset c} V_i \left(\frac{1}{a_{-g}^{c}}, C_{ij}^{-g} \left(\frac{1}{a_{-g}^{c}} \right) \right) > \sum_{i \subset c} V_i \left(p_g \left(\frac{1}{a_g^{c}} \right) \left(\frac{1}{p_{-g}} \right) \right)$$

$$\sum_{i \subset c} V_i \left(\frac{1}{a_g^{c}}, C_{ij}^{g} \left(\frac{1}{a_g^{c}} \right) \right) > \sum_{i \subset c} V_i \left(p_{-g} \left(\frac{1}{a_{-g}^{c}} \right) \left(\frac{1}{p_g} \right) \right)$$

$$\sum_{-i \subset -c} V_{-i} \left(\frac{1}{a_g^{-c}}, C_{-ij}^{g} \left(\frac{1}{a_g^{-c}} \right) \right) > \sum_{-i \subset -c} V_{-i} \left(p_{-g} \left(\frac{1}{a_{-g}^{-c}} \right) \left(\frac{1}{p_g} \right) \right)$$

and
$$\sum_{-i \subset -c} V_{-i} \left(\frac{1}{a_{-g}^{-c}}, C_{ij}^{-g} \left(\frac{1}{a_{-g}^{-c}} \right) \right) > \sum_{-i \subset -c} V_{-i} \left(p_g \left(\frac{1}{a_g^{-c}} \right) \left(\frac{1}{p_{-g}} \right) \right)$$

Let us now revisit the example of Smart Phones with engagement platform (g). Apple's production of Smart Phones in Portugal would impose foregone gains for China (c) if $\sum_{i \subset c} V_i \left(p_{-g} \left(\frac{1}{a_{-g}^{c}} \right) \left(\frac{1}{p_g} \right) \right) < \sum_{i \subset c} V_i \left(\frac{1}{a_g^{c}}, C_{ij}^{g} \left(\frac{1}{a_g^{c}} \right) \right)$ as well as foregone gains for Portugal if

$\sum_{i \subset -c} V_i \left(p_{-g} \left(\frac{1}{a_{-g}^{-c}} \right) \left(\frac{1}{p_g} \right) \right) > \sum_{i \subset c} V_i \left(\frac{1}{a_g^{-c}}, C_{ij}^{g} \left(\frac{1}{a_g^{-c}} \right) \right)$ even when Portugal reveals a "Ricardian"

comparative advantage in producing Smart Phones i.e. $\omega > \frac{a_g^{-c}}{a_g^{c}}$. When leveraging resources in a

country for co-creation experiences through an engagement platform, even if that country produces a good for which it does not possess the "Ricardian" comparative advantage, it can generate a higher value than can be supported by the production of the good for which it possesses the "Ricardian" comparative advantage. By conventional economic thinking, which overlooks any distinction between the value generated through an experience of co-creation on an engagement platform and the value extracted from selling an experience generated through the use of an artifact

(smart phone), the Principle of Comparative Advantage has been construed to imply that a country will gain from specializing (if it specializes) in the production of an artifact (smart phone) when the relative price at which that artifact can be exchanged with a consumer exceeds the opportunity cost at which that artifact can be produced by the firm(s) located in that country. This is reminiscent of the conventional firm-centric view of value creation in which consumers become relevant only at the point of exchange and, in effect, the market is artificially separated from the process of value creation.

In sum, an understanding of the principle of comparative advantage remains incomplete without the cognizance of co-creation. Conventional adaptations of this principle has left us with normative rules that are increasingly becoming obsolete, and often misleading "as is", and the way it "ought to be" in the evolving co-creation economy. As we have shown, the relevance of Ricardo's vision can be restored through co-creation thinking. By recognizing that value is generated as a function of co-creation experiences, our Principle of Co-creation Comparative Advantage provides a foundation for identifying gains from trade *beyond the conventional segregation of the role of the individual* (employee/consumer) from that of the firm in the process of value creation.

4. Concluding Remarks

In this paper, we have made an effort to bridge the widening gap between economic thinking on the principle of comparative advantage and the trading economy as it is evolving. Unlike the pre-internet industrial era, value is no longer viewed as a creation of the firm through its product and service related activities. Instead, the rapidly changing elements of our economy place the

individual at the center of value creation in sharp contrast with the firm-centric view that conventional economic theory is hesitant to let go. We have shown that the transition from a firm-centric view to a co-creation view has non-trivial implications for the principle of comparative advantage. We provide a framework that can align economic thinking on the principle of comparative advantage with complete cognizance of co-creation experience. We show how patterns of specialization and the resultant gains from trade, within or across borders, are affected by co-creation experiences. A natural outcome of our analysis is the Principle of Co-Creation Comparative Advantage, that can guide trade with co-creation at the core, expands our vision to identify mutual gains from specialization, as well as diversification, through co-creation. We hope our contribution will form the foundation for a new generation of forward-looking economists with a shared vision of the increasingly Internetworked world of economy.

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