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Domestic Rivalry and Export Performance:

Theory and Evidence from International Airline Markets

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Abstract: The much-studied relationship between domestic rivalry and export performance consists of those supporting a national-champion rationale, and those supporting a rivalry rationale. While the empirical literature generally supports the positive effects of domestic rivalry, the national-champion rationale actually rests on firmer theoretical ground. We address this inconsistency by providing a theoretical framework that illustrates three paths via which domestic rivalry translates into enhanced international exports. Furthermore, empirical tests on the world airline industry elicit the existence of one particular path – an enhanced firm performance effect – that connects domestic rivalry with improved international exports.

JEL: L52, L40, L93

I. INTRODUCTION

The impact of domestic market structure on export performance has received a good deal of scholarly attention since the 1970s. The literature was sparked by White (1974) and has been fanned by the work of a number of well regarded scholars (e.g., Caves, 1982; Audretsch & Yamawaki, 1988; Porter, 1990). At the risk of oversimplifying, the literature can essentially be reduced to two camps: those supporting a national-champion rationale, and those supporting the salubrious impact of domestic rivalry. Supporters of the national-champion rationale (Pagoulatos & Sorensen, 1976; Marvel, 1980; Krugman, 1984; Chou, 1986) argue that large domestic operations – disabled by domestic competition – provide national firms with economies, and these economies allow firms to earn large shares and profits in export markets. Supporters of the rivalry rationale (Ray, 1981; Audretsch & Yamawaki, 1988; Porter, 1990; Clark *et al.*, 1992; Kim & Marion, 1997; Sakakibara & Porter, 2001; Hollis, 2003) argue that domestic rivalry – enabled by domestic market competition – provides national firms with vigorous and real pressures to improve and innovate, and these improvements allow firms to earn large shares and profits in export markets.

The majority of empirical studies – particularly those that take a pan-industry perspective – support the rivalry rationale; hence, domestic competition appears to generally be the means to enhance the exports of national industries.[1] Interestingly, however, the literature on domestic market structure and export performance has a scarcity of theoretical work in support of the rivalry rationale. We only found four studies (White, 1974; Clark *et al*., 1992; Kim & Marion, 1997; Hollis, 2003) that explicitly model the beneficial impact of domestic market competition on export performance. All the more striking when you consider Martin's (1999) observation that the national-champion rationale – though empirically less robust – falls on more solid theoretical foundations than the rivalry rationale.

Furthermore, the few studies that formally model the positive impact of domestic competition on export performance suffer from some limitations. White's (1974) work is inspirational, but the analysis

[1] Some industry-based studies (e.g., Parsons & Ray, 1975 with the steel industry) find a positive relationship between domestic concentration and national exports; but only Pagoulatos and Sorensen (1976) find a statistically significant positive relationship between domestic concentration and exports while employing cross-industry data.

only allows domestic market concentration to impact exports via price-discrimination and dumping as he restricts market settings to perfect competition and monopoly. Clark *et al*. (1992) build a dominant firm model with a competitive fringe in an integrated world market: here when the fringe increases output (i.e., more domestic fringe firms), the dominant firm's price is lowered thus increasing exports.[2] Accordingly, both frameworks do not allow for either imperfect competition or economies between domestic and international production: both of which are generally regarded today as appropriate for policy-relevant international markets (Martin, 1999). Kim and Marion (1997) and Hollis (2003) do formulate oligopolisitic models – respectively employing a conjectural variations and a Cournot approach – to understand the effect of domestic rivalry on export performance; yet, the enhanced exports in these settings are due principally to the strategic effect of having multiple national competitors in world markets. In essence, their rivalry effect involves equivalence between domestic competitors and the number of national competitors in export markets.

Beyond the observation that the formal theoretical backing behind the rivalry rationale lacks both scale and depth rests some concerns we have with the empirical literature. The empirical work is almost universally undertaken at a broad level-of-analysis: where some measure of export performance (e.g., world market share, net exports, export revenue) is regressed on some measure of domestic rivalry (e.g., four-firm concentration ratio, Herfindahl-Hirschman-Index, instability in market shares) at the industry-wide level of analysis. The broad level-of-analysis makes it difficult then to elicit the different paths via which domestic rivalry might impact export performance. For instance, the number-of-competitors effect – focused on by Kim and Marion (1997) and Hollis (2003) – is an important conduit, yet additional paths may connect domestic rivalry to export performance: 1) the impact of domestic rivalry on the size of firms' domestic operations may affect export performance when there are joint-economies of production between domestic and international output; 2) domestic rivalry may also pressure firms to improve product quality and/or productivity, thus enhancing the competitiveness of home firms in international

[2] If there is more than one firm in the dominant group, Clark *et al.* (1992) assume that these firms can collude and choose a cartel price—a cartel price that falls as the fringe increases output.

markets. All of these effects are likely to be part of the net-effect which the empirical literature finds between domestic concentration and rivalry, but the previous empirical approaches are unable to tease out the different effects due to the broad level-of-analysis.

Motivated by the above three points – the scarcity and limits to the theoretical literature and the broad nature of the empirical work on the rivalry rationale – we attempt to provide a theoretical framework for the rivalry rationale that encompasses the different paths (a number-of-competitors, a joint-economies of production, and an enhanced-performance of competitors effect) via which domestic rivalry might impact export performance. We pay particular attention to the enhanced-performance of competitors effect (what might be referred to as a pure rivalry effect), as this is oft-quoted as a motivating rationale but also oft-neglected in both the empirical and theoretical literatures. For instance, both Kim and Marion (1997) and Hollis (2003) motivate their analysis with the potential for rivalry to enhance firm competitiveness; yet, their theoretical constructs essentially focus on the number-of-competitors effect. Accordingly, an important contribution by this piece is the attempt to formalize what scholars often consider to be the heart of the rivalry rationale: domestic rivalry requires firms to innovate and improve.

We also attempt to link theory to empirics; and as with our special emphasis on enhanced firm performance in the theoretical section, we also focus on that same neglected – but important – path in the empirical section. We empirically test for the impact of rivalry on firm performance while abstracting away from the number-of-competitors effect and holding constant any joint-economies of production effect. The proposed rivalry rationale is tested on comprehensive data covering the international airline markets between nineteen nations over 1987-1992. We find evidence that domestic rivalry (as measured by number of domestic competitors) does indeed enhance airline-specific exports in international markets; i.e., we empirically elicit the positive impact of domestic rivalry on firm-level international performance.

In order to support our analysis, the paper is structured as follows. Section II sets the basic theoretical model, considers the three different paths via which domestic rivalry may impact exports, and generates a testable proposition. Section III explains the world airline industry data. Section IV discusses econometric issues. Section V presents the empirical results. Section VI concludes.

II. THEORETICAL MODEL AND EMPIRICAL IMPLICATION

We consider a model with two markets – one domestic and one international – and one industry: likely the simplest structure in which our main problem can be addressed. There are *n* home firms that sell their output and compete in both the domestic and international markets (referred to as 'home-international' firms). They encounter competition in the domestic market from *m* other home firms, which strictly sell in the domestic market (referred to as 'home-domestic' firms). In the international market, the *n* home firms compete with *f* foreign firms, each of whom may come from different countries other than the home country. In this set-up, the domestic market is served only by home firms: such a set-up is not crucial for our insights to go through, but is indicative of the airline industry where we empirically test.[3]

Within each of the three groups (home-international, home-domestic, and foreign firms), we consider the firms to produce homogeneous output. Denote aggregate quantities in the domestic market by X (for home-international) and Y (for home-domestic) where $X = \sum_{i=1}^{n} x_i$ and $Y = \sum_{j=1}^{m} y_j$, and corresponding inverse demand functions by $p^x(X,Y)$ and $p^y(X,Y)$. In the international market, variables are denoted by a 'hat'; hence, the aggregate quantities by $\hat{X} = \sum_{i=1}^{n} \hat{x}_i$ and $\hat{Z} = \sum_{k=1}^{f} \hat{z}_k$ (for foreign firms), and the inverse demand functions by $\hat{p}^x(\hat{X},\hat{Z})$ and $\hat{p}^z(\hat{X},\hat{Z})$. In each market, the outputs of competing firms are 'strategic substitutes' (Bulow *et al.*, 1985). Further, total costs of a home-domestic firm and a foreign firm are $\alpha_y y_j$ and $\hat{\alpha}_z \hat{z}_k$ respectively, with α_y, $\hat{\alpha}_z$ representing constant marginal costs. To illustrate the joint-economies effect, we consider the quadratic cost for a home-international firm, $c(x_i,\hat{x}_i) = \alpha_x x_i + \hat{\alpha}_x \hat{x}_i - (\beta_x x_i^2 + 2\theta x_i \hat{x}_i + \hat{\beta}_x \hat{x}_i^2)/2$.[4] With $\partial^2 c / \partial x_i \partial \hat{x}_i = -\theta$, it is said, for a home-international firm, that joint-economies of production (or economies of scope) exist

[3] For example, as discussed below, nations generally do not import airline services in the sense that domestic routes are the exclusive prerogative of home-nation airlines; yet, the airline service markets between nations are usually served by both home and foreign airlines. In airline terminology, 'cabotage' – the right to provide air services between points within a single foreign country – has traditionally been almost non-existent.

[4] Note that these total-cost specifications are not subject to a constant term (fixed cost); though, the addition of such a term won't affect the results reported in this section.

across the domestic and international markets if $\theta > 0$, i.e., an increase in the output for one market reduces the marginal cost for the other market.[5] Furthermore, there are dis-economies of production if $\theta < 0$, whereas there are no-relations in production if $\theta = 0$.

Given these demand and costs, each firm's profit (π^i, π^j, π^k) is specified; and multi-market competition is then modeled as a Cournot game:[6]

$$\underset{x_i, \hat{x}_i}{Max}\ \pi^i, \qquad \underset{y_j}{Max}\ \pi^j, \qquad \underset{\hat{z}_k}{Max}\ \pi^k \qquad i = 1, \cdots, n, \ \ j = 1, \cdots, m, \ \ k = 1, \cdots, f.$$

Here, the domestic and international markets are 'segmented' in the sense that home-international firms choose distinct quantities, x_i and $\hat{x}_i$, for each market (Brander, 1981; Brander & Krugman, 1983).[7] Yet in the present model, market segmentation does not necessarily imply that firms separately choose profit-maximizing quantities for each market, as there are cost-side interactions. Cost-side interactions are absent if $\theta = 0$; only in that case, will the two markets be independent and the equilibrium quantities of the domestic and international markets be determined by two separated sets of equations. Thus the Cournot equilibrium ($x_i, y_j, \hat{x}_i, \hat{z}_k$) is, in general, characterized by the ($2n + m + f$) first-order conditions.[8]

Effects of domestic rivalry on export market share are obtained by conducting comparative statics of the Cournot equilibrium. Following Kim and Marion (1997) and Hollis (2003), we use the number of home firms as a proxy for domestic rivalry. In our context, however, an increase in domestic rivalry can correspond to an increase in *n*, an increase in *m*, or both. In particular, the comparative static effect of *n* – the number of home-international firms – shows that if joint-economies exist, an increase in *n* results in domestic output expansion by home-international firms as a whole. This output expansion in turn will

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[5] Note that when the domestic and foreign outputs are homogeneous, joint-economies imply declining marginal costs of production $c''(\cdot) < 0$. Declining marginal costs have been used in the airline literature (e.g., Brueckner & Spiller, 1991) to model density economies. See Section III for further discussion of this issue.

[6] Brander and Zhang (1990, 1993) empirically support that rivalry between oligopoly airlines is consistent with Cournot behavior.

[7] With segmented markets, firms can price discriminate across domestic and international markets. Accordingly, prices won't necessarily be equalized by international trade as in the case of an 'integrated' world market. In the context of our empirical work, the domestic and international airline markets are segmented due to regulatory restrictions. Kim and Marion (1997) assumed segmented markets; Clark *et al.* (1992) and Hollis (2003) used integrated markets; and White (1974) discussed both cases.

[8] Regularity conditions are imposed for the existence, uniqueness and stability of the equilibrium (see Appendix A) so that comparative static exercises conducted in the paper are meaningful.

spillover to the firms' international sales – a 'joint-economies of production' effect (Clougherty & Zhang, 2005). Furthermore, the comparative static effect of *n* will imply the 'number of competitors' effect: when firms compete in strategic-substitutes fashion, an increase in the number of home firms competing in the international market increases the country's export share.[9] As noted earlier, Kim and Marion (1997) and Hollis (2003) analyze the increased-competitors effect.[10]

Although our model can be used to illustrate the positive impact of more home competitors on export market shares, we won't be testing this number-of-competitors effect with our data for a few reasons. First, our data are firm-based – as opposed to the industry-based data employed in previous empirical studies – in order to elicit the enhanced firm performance effect we described in the introductory statements. In the analysis with respect to an increase in *n*, although export market share for home firms as a whole goes up, export market share *per home firm* may or may not go up.[11] Accordingly, the number-of-competitors effect yields no clear prediction vis-à-vis firm-based market shares. Second, our data contain a relatively high number of entries/exits by home-domestic firms as compared to home-international firms; thus, requiring an analysis of an increase in *m* – the number of home-domestic firms. As seen below, the analysis with respect to *m* also allows us to produce export performance predictions that are firm-specific, which will facilitate our empirical tests.

The number-of-competitors effect outlined above is important and currently appears to represent the state of the art for modeling the rivalry rationale; however, we think the essence of the rivalry rationale

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[9] Detailed derivation of these two results is available upon request. Note also that since there are no imports in the present model, 'exports' or 'export market share' are, throughout the paper, equivalent to 'net exports' or 'net export market share'.

[10] Effects similar to this increased-competitors effect have been analyzed by a number of scholars in the context of merger/competition policy and international trade (e.g., Dixit, 1984; Ordover & Willig, 1986; Barros & Cabral, 1994; Bliss, 1997; Horn & Levinsohn, 2001; Huck & Konrad, 2004). The effect is related to a well-known result found by Salant *et al.* (1983): in a Cournot market, a merger of two firms into one entity reduces the participants' profit (unless the merger leads to a monopoly). By internalizing part of the effect that a firm's quantity decision has on the rivals' profits, the merged entity sets its quantity too low, thereby yielding market share to the non-participating firms. In the case of international competition, market share would be yielded to foreign firms when two home firms merge.

[11] *Proof*: Using $\hat{s}_i$ to denote the export market share per home firm, then $\hat{s}_i = \hat{x}_i /(\hat{X} + \hat{Z}) = \hat{S} / n$, where $\hat{S} = \hat{X} /(\hat{X} + \hat{Z})$ is the export market share by the home firms as a whole. Further, $d\hat{s}_i / dn = -\hat{S}(1-e)/n^2$, where $e \equiv (n/\hat{S})\hat{S}_n$ is the elasticity of changes in the home firms' aggregate export share with respect to *n* (with $\hat{S}_n \equiv d\hat{S}/dn$). Thus, $d\hat{s}_i / dn > 0$, $= 0$ and < 0 if $e > 1$, $= 1$ and < 1, respectively. In particular, while overall export share rises as the number of home competitors increases ($e > 0$), the export share of a particular home firm actually falls when $e < 1$.

may rest elsewhere. Our analysis below – both theoretical and empirical – will abstract from the increased-competitors effect. In the theoretical analysis, this is done by increasing *m* but holding *n*, the number of home participants in the international market, constant. First, in the absence of a 'rivalry rationale', Proposition 1 below shows that if joint-economies exist, an increase in *m* would reduce exports. This suggests a *negative* relationship between domestic rivalry and export performance, in contrast to both the joint-economies and increased-competitors effects discussed above. The economic intuition behind this result is that an increase in home-domestic firms will, holding other factors constant, crowd out some of the domestic output from each home-international firm. If there are joint-economies, the domestic output contraction further leads to an export contraction by each home-international firm. It can be further shown that in this case, an increase in the number of home-domestic firms would reduce each home-international firm's domestic market share.[12] In essence, this dynamic reflects the national champion rationale where large domestic operations allow firms to reap economies for international competition. Note that the opposite obtains if there are dis-economies in production across the markets.

Facing such a threat to competitive position, home-international firms may respond by economizing on costs, eliminating poor managerial practice, or improving product quality. Porter (1990) argues that intensive domestic rivalry pressures firms to upgrade product quality while fostering positive static and dynamic externalities in the local business environment (e.g., supplier availability, easier access to technology and market information, specialized human resource development). Enhanced local rivalry not only gives rise to positive externalities, but creates stronger competitive incentives together with greater pressures to upgrade productivity since local rivals neutralize advantages due to input costs and other local business conditions (Sakakibara & Porter, 2001).[13] While Porter's (1990) work is based largely on case studies, a large number of econometric studies exist that examine the impact of product market competition on firm-level efficiency (see Nickell, 1996, Baggs & Bettignies, 2007 for surveys on theoretical and empirical contributions). For instance, Nickell (1996) finds, based on a sample of U.K.

[12] While home-international firms produce less in this case, the output expansion by home-domestic firms outweighs that reduction, hence domestic prices fall.
[13] In this theory, domestic firm rivalry offers greater benefits to competitive upgrading than either imports or limited foreign direct investment.

companies, that increased number of competitors significantly increases total factor productivity growth, whereas Bloom and Van Reenen (2007) find evidence supporting product market competition to eliminate poor managerial practice and that better managerial practice is in turn significantly associated with higher productivity and profitability. [14]

Beyond providing a solid literature review, Baggs and Bettignies (2007) isolate the 'agency effect' from the 'direct pressure effect' of competition in their theoretical model, and then empirically test using Canadian survey data. They conclude that competition has a positive direct pressure effect: "Even in firms in which agency costs are absent, competition increases the importance firms place on quality improvements and cost reductions" (Baggs & Bettignies, 2007: 290). Their analysis implies that increased domestic rivalry may change home-international firms' behavior, which in turn would reduce the costs and/or increase the demands they face in competitive markets. We shall capture this rivalry hypothesis by simply introducing a variable *r*, which, according to the above discussions, increases in *m* and satisfies

$$p_r^x(X,Y) - c_{xr} (\equiv \partial p^x / \partial r - \partial^2 c / \partial x \partial r) > 0, \qquad \hat{p}_r^x(\hat{X},\hat{Z}) - c_{\hat{x}r} > 0 \qquad (1)$$

The first inequality in (1) indicates that an increase in *r* would lead to an increase in a home-international firm's marginal profit in the domestic market, and that this positive effect is a consequence of an outward shift in its domestic demand (due, e.g., to quality improvement), and/or a reduction in marginal cost. Similarly, the second inequality concerns the effect on the firm's international market.[15]

Proposition 1: (a) In the absence of a rivalry rationale, an increase in home-domestic firms would reduce, increase, or not-effect each home-international firm's export market share if there are respectively joint-economies, dis-economies, or no-relations in the production of domestic and international output. (b) Under the rivalry rationale, an increase in home-domestic firms would – in the absence of the joint-economies effect – increase each home firm's export market share.

[14] For the airline sector, deregulation and ensuing competition in the U.S. airline industry is shown to significantly improve airline productivity (e.g., Graham *et al.*, 1983). More recently, based on a panel of major U.S. and European airlines, Ng & Seabright (2001) find, after controlling for state ownership and other factors, that the more firms on a route the lower firm costs and rents.

[15] Intensified domestic rivalry may also conceivably affect the home-domestic firms' behavior and performance; however, incorporating this change won't alter our analytical results. To be concise, we shall not consider this rivalry impact further.

The proof of Proposition 1 is given in Appendix A. As can be seen from the proof, the export effect of domestic rivalry is given by (subscripts again denoting partial derivatives),

$$\hat{X}_m (\equiv d\hat{X} / dm) = (-\Pi^{\hat{Z}}_{\hat{Z}\hat{Z}} / \Delta)\left(\Pi^{\hat{X}}_{\hat{X}X}\Pi^{X}_{XY}\Pi^{Y}_{Ym} - \Pi^{Y}_{YY}\Pi^{\hat{X}}_{\hat{X}X}\Pi^{X}_{Xm} + \Delta_1\Pi^{\hat{X}}_{\hat{X}m}\right). \quad (2)$$

Three terms reside on the RHS of (2). The second and third terms are unique to the rivalry hypothesis: if they drop out, then the remainder (the first) term has the opposite sign of θ (see Appendix A) and Proposition 1(a) follows. Since $\Pi^{X}_{Xm} = (p^x_r - c_{xr})r'(m) > 0$ by (1), the second term has the same sign as that of $\Pi^{\hat{X}}_{\hat{X}X} = \theta / n$ or θ, thus the opposite sign of the first term. Here, increased rivalry – due to home-domestic firms' entry – improves home-international firms' domestic marginal profits, thus allowing them to commit to greater domestic output, which in turn improves their exports if joint-economies exist across markets. While the first two terms in (2) produce opposite forces on home exports, the last term is always positive since $\Pi^{\hat{X}}_{\hat{X}m} = (\hat{p}^x_r - c_{\hat{x}r})r'(m) > 0$ by (1). The intuition behind the rivalry hypothesis is straightforward: increased rivalry improves – via resulting in demand and/or supply side improvements to a firm's competitiveness – home-international firms' performance in the international market, which in turn increases exports. Notice that when $\theta = 0$ – i.e., the joint-economies effect is turned off – the first two terms in (2) vanish. In this case, $\hat{X}_m > 0$ is due solely to the last term – so Proposition 1(b) follows. This last term – the tendency for domestic rivalry to increase export market share through the rivalry effect – may be termed the 'enhanced-performance of competitors' effect.

Proposition 1 is useful for our empirical testing. In particular, it allows us to produce export performance predictions that are firm-specific. To illustrate, we rewrite equation (2) as:

$$d\hat{x}_i / dm = (-\Pi^{\hat{Z}}_{\hat{Z}\hat{Z}} / \Delta)\left(A\theta + n\Delta_1\Pi^{\hat{X}}_{\hat{X}m}\right) \quad (3)$$

where $\hat{x}_i$ denotes exports of a typical home-international firm, and $A \equiv \Pi^{X}_{XY}\Pi^{Y}_{Ym} - \Pi^{Y}_{YY}\Pi^{X}_{Xm}$ represents the 'net' effect of the combined first and second terms in (2) on exports. This net effect may be positive, negative, or zero, depending on which effect from increased rivalry dominates: the immediate 'crowding out' effect (which corresponds to a national-champion type rationale), or the enhanced-performance of competitors effect vis-à-vis domestic competition. In particular, if $A = 0$, then the first term in (3) is zero. This term also equals zero if $\theta = 0$; i.e., there are no-relations in production across markets. In either case, $d\hat{x}_i / dm$ will be given by the second term, which is always positive regardless of the signs of A or θ. As noted above, this term's positive sign captures the enhanced-performance of competitors effect. Note that the term is weighted by $\Pi^{\hat{X}}_{\hat{X}m} = (\hat{p}^x_r - c_{\hat{x}r})r'(m)$; hence, the greater the competitive response following increased domestic rivalry, the greater the international-market-share gain. Consequently, this term yields a key insight that helps generate and formalize empirical tests. In particular, we shall test the enhanced-performance of competitors effect while controlling for the joint-economies of production effect and abstracting away from the number-of-competitors effect.

III. WORLD AIRLINE INDUSTRY DATA

We employ data from the world airline industry to test the impact of domestic rivalry on export performance. The airline industry represents a good setting to consider the relationship between domestic rivalry and exports for a few reasons: 1) the ability to isolate the domestic rivalry effects; 2) the conformity of the airline industry to an idealized setting for the national champion rationale; 3) the presence of joint-economies of production.

First, domestic and international airline markets are segmented due to regulatory restrictions: e.g., nations generally do not import airline services in the sense that domestic routes are the exclusive prerogative of home-nation airlines. Accordingly, home rivalry effects are purely domestic in that foreign airlines do not constitute any part of the domestic competitive environment. Furthermore, the airline service markets between nations – where home and foreign airlines compete for international passengers – represent the idealized third-country market for exports that the theoretical work uses as a basic set-up (e.g., Brander & Spencer, 1985; Krugman, 1984).

Second, the airline industry has been characterized as exhibiting the correct conditions for the tractability of the national champion rationale (Norman & Strandenes, 1994). The segmentation of international from domestic markets, the network economies from matching domestic with international routes and the imperfectly competitive nature of international airline markets fulfill Krugman's (1984) conditions for the national-champion rationale to hold. Furthermore, the prior that large domestic airlines perform better in international markets has been empirically supported (Clougherty, 2002, 2006). Accordingly, the airline industry represents a tough case to find evidence supporting the rivalry hypothesis in the sense that the national-champion rationale has traditionally been evident in the industry.

Third, the presence of economies between domestic and international production in the airline industry indicates the condition of joint-economies in production. These economies are founded in part on the presence of substantial density economies (fixed costs on a route are quite high, but the marginal cost of an additional passenger is quite low) which suggests that the matching of routes with a hub-and-spoke system can generate substantial economies via the feeding of traffic from one route to another. See Levine (1987), Brueckner and Spiller (1991, 1994), Brueckner *et al.* (1992), Borenstein (1992), and Oum *et al.* (1995) for how density economies played a role in the rise of domestic airline networks and concentration. These same principles apply to the matching of domestic with international operations (see Weisman, 1990; Oum *et al.*, 1993; Dresner, 1994; Clougherty, 2002, 2006). As noted in the theoretical section, joint-economies can be a key conduit between domestic rivalry and enhanced exports.

The actual data for the empirical tests derive from two series compiled by the International Civil Aviation Organization: the 'Traffic' (TRF) series, and the 'Traffic by Flight Stage' (TFS) series. The TRF series provides data on domestic traffic levels for the airlines competing in the international country-pair markets, as well as airlines competing solely in domestic markets. By compiling this data, we created measures of domestic rivalry – the main concept of interest – and additional control variables. The TFS series provides data on passenger traffic in international city-pair airline segments. By compiling this data, we created market share measures in order to capture exports in international airline service markets. The TFS data unfortunately include passengers flying between international city-pairs that have origins and/or destinations beyond the international segment city-pairs. While origin-and-destination (O&D) data best reflect airline industry competition (Morrison & Winston, 1987), such data do not readily exist for non-US international routes. The TFS data represent the best available alternative for studying the population of international airline markets. Nevertheless, we have attempted to reduce the measurement error involved with employing TFS data by aggregating the international city-pair segment data into international country-pair data. Clougherty (2006) argues that the hubbing-bias is less pronounced at the country-pair level of analysis.

The data are structured on an airline's performance in a particular country-pair market for a particular year; i.e., observations are at the airline/route/year level of analysis. Accordingly, 433 specific airline-routes (i.e., panels) reside within the total 1,889 observations. In order to give further details beyond the total number of observations and panels, consider that the data consist of thirty-seven airlines from nineteen nations over the 1987-1992 period.[16] The above clearly suggest the unbalanced nature of the panels; unsurprising, in light of airline practice to both enter and exit markets. Variable constructs are defined in more detail below; in addition, table 1 briefly describes the nature and source of the variables, while table 2 provides summary statistics by home-international airline.

In order to be sure that readers firmly grasp the actual regression estimations being considered, we represent here the fixed panel-and-period effects regression model:

$$\text{International-Market-Share}_{it} = b_0 + b_1 *(\text{International-Market-Share})_{it-1} + b_2 *(\text{International-Market-Share})_{it-2} + b_3 *(\text{Domestic-Competitors})_{jt} + b_4 *(\text{Domestic-Market-Share})_{kt} + b_5 *(\text{Domestic-Network})_{kt} + b_6 *(\text{Merger})_{kt} + b_7 *(\text{Foreign-Rivalry})_{kt} + b_8 *(\text{Domestic-Competitor-Network})_{kt} + b_9 *(\text{Home-Competitors})_{it} + b_{10}*(\text{International-Competitors})_{it} + \varepsilon_{it} + \alpha_i + \gamma_t \qquad (4)$$

where *i* indexes an airline's international country-pair market (433 of them), *j* indexes the nineteen countries, *k* indexes the thirty-seven airlines, *t* indexes time, α_i represents the fixed panel-specific effect, and γ_t captures the fixed period-specific effect.

[16] The data actually extend back to 1984, but observations for dependent variable measures from 1984-1986 do not go into the estimations in order to accommodate the various lag structures for the different regression techniques.

Our concept of principal interest – i.e., the dependent variable – is an airline's competitive performance in an international market. We use an airline's share of the revenue passengers in a particular international country-pair market to measure airline competitive performance (hereafter, International-Market-Share). To the degree that an airline competes in different country-pair markets, we have then multiple measures of an airline's competitive performance.

Our concept of principal explanatory interest – i.e., the main explanatory variable – is the domestic market rivalry experienced by a particular airline. We use the number of domestic competitors in the focal airline's domestic market to measure domestic rivalry (hereafter, Domestic-Competitors): with more domestic competitors clearly corresponding to more rivalry. While the reported empirical results are robust to alternative measures of domestic rivalry – logarithmic form of domestic competitors, a domestic Herfindahl-Hirschman-Index and a behavioral measure of domestic rivalry based on Sakakibara and Porter (2001) – domestic competitors more directly tests our theoretics: where an increase in home-domestic airlines represents enhanced domestic rivalry. We expect higher levels of domestic rivalry (more domestic competitors) to lead to enhanced export performance (higher international-market-shares).

In order to yield more robust causal inferences on the domestic-rivalry/export relationship, it behooves us to control for other potential drivers of international market share: airline domestic market share, airline domestic network size, domestic merger activity, international rivalry, competitor network size, and number of home and foreign competitors. While we discuss the importance of these variables below, it bares noting that the first two control variables – airline domestic market share and airline domestic network size – help control for the joint-economies of production effect. Any entry/exit induced changes to a focal airline's domestic operation size are held constant by the domestic market share (relative size) and domestic network size (absolute size) variables. Hence, the coefficient estimate for domestic competitors can be interpreted as eliciting the effect of domestic rivalry on firm performance in international markets and not the effect of rivalry on international-market-share via altering an airline's domestic operation size (the joint-economies of production effect). Accordingly, a particular airline's share of the total number of domestic passengers in its home domestic market (hereafter, Domestic-

Market-Share) and an airline's total number of domestic departures (hereafter, Domestic-Network) represent two important control variables.

While we have already observed that the airline industry involves a joint-economies of production effect, we outline here in more specificity why we expect a positive relationship between the above two variables and international-market-share. First, airlines with a large presence (market share) in domestic markets may also have a large presence in international markets. The monopolization of domestic routes allows airlines to take better advantage of density economies in these routes, but domestic routes also represent an input into international service; thus, efficient monopolization of domestic routes leads to enhanced efficiency in international operations. In support of this conjecture, Clougherty (2006) finds airlines dominant in domestic markets to perform better in international markets. Second, airlines also derive advantages from having large domestic networks: large domestic networks allow airlines to gather more passenger traffic to feed international route operations. Increasing the flow of passengers onto international flights allows airlines to better take advantage of density economies, and thereby earn a greater share of the traffic and profits in international routes (Oum *et al.*, 1993; Clougherty, 2002, 2006). In sum, the relative and absolute size of a particular airline's domestic operation may generate important international competitive advantages.

The inclusion of the domestic-network and domestic-market-share variables is driven both by the immediate rationales from the literature noted above, and by the desire to elicit the effect of rivalry on firm performance in international markets. Yet there is an additional implication of including these two variables: by attempting to independently capture any advantages airlines may hold by having large domestic networks or a large domestic presence, we are not necessarily setting up an empirical test of the national-champion versus the rivalry rationale – a contending theories set-up that is oft the norm in the empirical literature. Instead, we allow both rationales to empirically manifest themselves – a common-sense approach if one assumes that both theories exist for a reason. In other words, we can interpret the impact of domestic rivalry while holding constant two core forces (an airline's domestic market presence and network size) behind the national-champion contention.

Third, airline mergers may generate rationalizations involving independent effects – beyond simply the domestic-presence and domestic-network effects – on international market shares. In support of this, Clougherty (2002, 2006) finds airlines engaging in domestic mergers to have improved international performance as compared to airlines not engaging in domestic mergers. We employ the data compiled in those studies that identifies and codes the international airlines engaging in domestic mergers over1984-1992. Thus, we include a merger dummy variable (hereafter, Merger) that is coded 1 for the year when an airline first engages in a domestic merger within the study period and for all subsequent years.

Fourth, in order to ensure that domestic rivalry is the actual benchmarked-source of competition for international airlines, we control for the rivalry faced by an airline in its various international markets. Porter (1990) holds that foreign competition does not have an equivalent effect to that of home domestic-market competition. We test this prior by including a measure of the average number of competitors an airline faces in its various international country-pair markets (hereafter, International-Rivalry).

Fifth, it behooves us to control for some of the properties of other home competitors in the domestic market in which a particular airline is embedded. For instance, while there may be advantages to being based in a very large domestic market (e.g., ability to generate substantial network economies via both the supply and the demand side), large domestic markets may also allow home competitor airlines to draw upon substantial network economies. In short, the network size of home competitor airlines (both home-domestic and home-international) may represent a competitive threat to a focal airline. Accordingly, we control for the total number of domestic departures for all the other home competitors that an airline faces in its home domestic market (hereafter, Domestic-Competitor-Network).

Sixth, it is imperative to control for the number of competitors (both home and foreign) an airline faces in an international country-pair market. The number of home-based and foreign-based competitors (hereafter, Home-Competitors and Foreign-Competitors respectively) captures a very basic driver of an airline's actual international-market-share in a particular country-pair market. Note that this number of competitors effect is different to that in the theoretical section, as we abstract away from how the number of home-nation competitors may enhance national exports by simply looking at the exports of one particular airline. Yet, a particular airline's market share will still be a function of the number of competitors it faces in that international market. For instance, it would be reasonable to expect an airline facing one competitor to have a much higher market-share as compared to an airline facing five competitors. Moreover, we will also employ the natural-logs of the home and foreign competitors, as these constructs are prone to be non-linear in functional form.[17]

IV. ECONOMETRIC ISSUES

Properly analyzing panel data on airline performance in international country-pair markets requires consideration of a number of econometric issues. This section considers and focuses on the following issues: model-specification, time trends, panel data approach, serial correlation and heteroskedasticity, and endogeneity of both the lagged-dependent and primary explanatory variables.

First, the empirical tests employ a dynamic panel-data model – a model where the lagged dependent variable is included as an explanatory variable – to estimate the appropriate coefficient estimates. Finkel (1995) notes that such an approach is appropriate when the dependent variable is not created anew each period. Wooldridge (2002: 307) states that such an approach is often "intended to simply control for another source of omitted variable bias." The autoregressive dynamics in our case are surely influenced by both of the above, and by the intuition that autoregressive dynamics allow estimating the effect of the primary causal variables while holding constant any prior market advantages an airline will have in a particular country-pair market. Consequently, causal-variable coefficient estimates measure short-term – not long-term – effects on the dependent variable.

Second, international airline markets have been subject to a number of changes over the period of study. Liberalization of international markets, increasing competitiveness of airlines, and the demise of cartel-like arrangements – are all examples of gradual changes in the international airline environment. Furthermore, sudden changes (e.g., the travel recession of the first Gulf War) may also impact the

[17] To ease problems with logarithmic transformation of zero values, we add 1 to both home and foreign competitors.

competitive environment. Both gradual and sudden changes to the world airline environment may create time-specific data trends that affect causal inferences; hence, all estimations employ fixed period effects.

Third, panel data often requires a choice between the fixed-effects and random-effects methods. Random-effects models tend to be more efficient than fixed-effects, but come with the big assumption of zero correlation between the observed explanatory variables and the unobserved panel effect. Fixed-effects have the advantage of not imposing a specified panel relationship, and not assuming zero correlation between the observed explanatory variables and the unobserved panel effect (Wooldridge, 2002); though, they do come at the cost of requiring significant degrees of freedom. Fixed-effects models are often called for when the panel-specific effects are unique and unrelated to other panels (Hsiao, 1986; Greene, 1990), and international country-pair airline markets also contain unique panel characteristics that are difficult to control. In support of the above conjecture, Hausman (1978) tests favor the use of the more conservative – though less efficient – fixed-effects method. In short, the tests suggest that the relatively strong assumptions behind the random-effects estimator do not hold, and that fixed-effects yields more consistent coefficient estimates. Nevertheless, we will also report random-effects results to underscore the robustness of the findings.

Fourth, the inclusion of a lagged dependent variable – while appropriate – leads to additional econometric issues, as exogeneity simply cannot hold in an autoregressive environment. Wooldridge (2002: 313) notes that when using lagged dependent variables "it is a good idea … to use a full GMM approach that efficiently accounts for these." In order to directly address the endogeneity of the lagged dependent variable, we undertake a Generalized Method of Moments (GMM) estimation in order to properly account for autoregressive dynamics. We employ the Arellano-Bond GMM two-step estimator where the model is treated as a system of equations. Though asymptotically more efficient, the standard error estimates from the two-step procedure tend to be downward biased as compared to the one-step procedure (Arellano & Bond, 1991; Blundell & Bond, 1998); hence, we also make use of Windmeijer's (2005) correction for the two-step covariance matrix.

Fifth, it behooves us to ensure that any additional arbitrary serial correlation or heteroskedasticity does not impinge upon confidence in the empirical results. Wooldridge (2002) notes that heteroskedasticity in the residuals is always a potential problem, but that serial correlation is particularly important in certain applications: our autoregressive panel dynamics is certainly a case where serial correlation is of principal concern. Accordingly, we also employ a robust variance matrix estimator (Huber/White standard errors for estimated coefficients) to account for possible heteroscedasticity and autocorrelation in the regression estimations that do not employ the Windmeijer correction.

Lastly, and most importantly, we must have confidence that our main explanatory variable – domestic competitors – exhibits exogeneity and consistency in coefficient estimates. In order to test for the exogeneity of domestic-competitors, we take as a base the above GMM estimations where the lagged dependent variables are treated as endogenous, and then run an additional GMM estimation where both the lagged dependent variables and domestic-competitors are considered endogenous. Akin to the Durbin-Wu-Hausman (DWH) test, we consider whether the coefficient estimate for domestic competition under the GMM treatment (where domestic-competitors acts as its own instrument) converges to the coefficient estimate for domestic competition under the GMM treatment (where domestic-competitors is instrumented for). The DWH test suggests – as does a casual consideration of the coefficient estimates for domestic-competitors in Regression #3 and #4 of Table 3 – some endogeneity on the part of domestic-competitors.

Some additional information on the nature of the endogeneity can be gained from the diagnostics commonly associated with GMM treatments. Two assumptions must hold for the consistency of GMM system measures: 1) the disturbances must be serially uncorrelated – i.e., no second-order serial correlation can be present in the first-differenced residuals; 2) the instrumental variables must be uncorrelated with the first-differenced residuals. First, we report the Arellano-Bond test for second-order serial correlation in first-differences in all GMM estimations. These results suggest no second-order serial correlation in first-differences once a second lagged dependent variable is introduced; hence, our autoregressive dynamics will consistently involve two lags of the dependent variable. In short, neither regression #3 nor #4 appears subject to second-order serial correlation.

Second, we report difference-in-Hansen (1982) statistics for two subsets of instrumental variables used in the GMM estimation procedure: the first-differenced instruments involved in the levels-equation, and the additional instruments used beyond the lagged values for estimating the designated endogenous variables.[18] First, the reported results consistently support the validity of the instruments for the levels equation in the GMM procedure, thus suggesting the correctness of the GMM technique with regard to this aspect. However, the reported results for the additional instrumental variables only indicate validity in Regression #4: where domestic-competitors is treated as endogenous and thus is not included as an instrumental variable. In regression #3 – where domestic-competitors is assumed to be exogenous and included as an instrumental variable – the difference-in-Hansen test indicates invalidity of the instruments: i.e., the instruments do not reduce correlation between the explanatory variables and the error term.

The above suggests the advisability of treating domestic-competitors as endogenous, instrumenting for this variable using the GMM procedure, and of course placing emphasis on theose instrumented empirical results from regression #4. Table 3 presents four different estimation methods to reflect the above econometric concerns. Regression #1 reports the random-effects procedure, while regression #2 reports the fixed-effects procedure supported by a Hausman test. Regression #3 reports the GMM estimation procedure where the two lagged dependent variables are treated as endogenous. Regression #4 reports the GMM estimation procedure where the two lagged dependent variables and domestic-competitors are treated as endogenous.

V. EMPIRICAL RESULTS

The model appears to be reasonably well specified in the sense that the random-effects and fixed-effects estimations yield relatively high R^2s: 0.92 and 0.79 respectively in Regressions' #1 & #2.

[18] The variables employed as instruments in Regression #3 for 'Additional Instruments' include the lagged values of domestic-competitors, domestic-market-share, domestic-competitor-network, international-rivalry, the merger dummy, home-competitors, and the airline's number of flights in the country-pair market; plus, the GMM procedure takes advantage of lagged values for the endogenous variables (the two lagged dependent variables). The variables employed as instruments in Regression #4 for 'Additional Instruments' include the lagged values of domestic-market-share, domestic-network, domestic-competitor-network, international-rivalry, the merger dummy, home-competitors, and foreign-competitors; plus, the GMM procedure takes advantage of lagged values for the endogenous variables (the two lagged dependent variables and domestic-competitors).

Furthermore, and as already noted, the difference-in-Hansen tests for overidentification in the GMM estimations suggest the validity of the instruments and the correctness of the model specification for regression #4. Accordingly, we will concentrate on discussing the empirical results from regression #4 of Table 3. Nevertheless, the results tend to be both significant and consistent across the different estimation techniques. Below, we first discuss the results of the various control variables before considering the results for the explanatory variable of principal interest: domestic-competitors.

The coefficient estimate for an airline's domestic market share is positive and significant in regression #4 as expected. The coefficient estimate of 0.031 from Regression #4 suggests that an airline increasing its domestic market share by thirty-two percentage points might find its market shares in various international country-pair markets to increase by 1 percentage point on average. The coefficient estimate for an airline's domestic network is consistently positive per expectation and significant in all four regression estimations. The coefficient estimate of 4.67 from Regression #4 suggests that an airline increasing domestic network size by 214,132 annual domestic departures might find its market shares in various international country-pair markets to increase by over 1 percentage point on average. The coefficient estimate for the merger dummy variable is positive and significant at the 5% level in regression #4. The coefficient estimate suggests that airlines completing domestic mergers enhance their market shares in various international country-pair markets by 1.61 percentage points per year on average. Accordingly, airline's engaging in domestic merger activity may reap additional gains in international country-pair markets beyond the domestic network-size and market-share effects. The coefficient estimate for the domestic network of home competitors is -50.4 and significant at the 1% level in regression #4. That coefficient estimate suggests that airlines with home competitors experiencing an increase in their domestic networks of 1 million departures find their market shares in international country-pair markets to decrease by a half percentage point on average. The coefficient estimates for home-competitors and foreign-competitors both generally conform to expectation with negative signs and significance in all four regression estimations (except foreign-competitors in Regression #3). Recall that these variables are expressed in their natural logs in order to account for non-linearities.

Finally, our variable of principal concern – domestic competitors – yields coefficient estimates that are consistently positive per expectation and significant in all four regression estimations. The coefficient estimate of 0.051 for domestic-competitors in regression #4 – where the GMM system estimation is employed for both the lagged dependent variables and domestic-competitors – suggests that an additional domestic-competitor (enhanced rivalry) may lead to an increase in an airline's market shares in various international country-pair markets by 0.05 percentage points on average. In order to better grasp the economic meaning of this finding, we take some actual changes and comparisons in domestic competition to factor the significance of this effect. For instance, the Canadian domestic airline market went from five competitors in 1989 to two in 1991; thus, suggesting that the decreased conditions for rivalry in the Canadian domestic market might result in a 0.15 percentage point decrease in market shares for Canadian airlines in their various international country-pair markets. Furthermore, the number of domestic-competitors in the UK averaged just a little under twenty-three over this period while the French domestic market averaged around seven; thus, suggesting that UK airlines would generally have almost a 1 percentage point advantage as compared to French carriers in international country-pair markets due to the greater rivalry in UK domestic markets. Hence, the empirical results do suggest then that domestic competition plays a role in explaining airline performance in international markets. In other words, domestic rivalry can lead to the enhancement of airline-specific exports.

VI. CONCLUSION

In sum, we find domestic rivalry to positively impact the international market shares of airlines. Accordingly, airlines that experience substantial domestic rivalry tend to perform better in export markets. While empirically finding a positive relationship between domestic rivalry and exports does not represent a substantial new finding (the majority of empirical scholarship finds a positive relationship between domestic rivalry and export performance), our results are unique in that we do not simply capture a net-effect for domestic rivalry where a number of different paths might connect domestic-rivalry with exports. We instead use firm-level market data to elicit an enhanced-performance of competitors effect: what most scholars consider to be the heart of the rivalry rationale. We find domestic rivalry to improve the performance of firms while abstracting away from the number-of-competitors effect and holding constant the joint-economies of production effect – two effects lurking behind previous empirical work. Furthermore, finding the rivalry rationale to be empirically robust in the context of the world airline industry is noteworthy, as this industry has traditionally supported the national champion rationale. Additionally, our theoretical analysis provides a useful framework for isolating the enhanced-performance of competitors effect from both the number-of-competitors effect and the joint-economies of production effect.

The analysis here nevertheless suffers from some omissions and deficiencies that further scholarly work may be able to address. First, while we empirically test the enhanced-performance of competitors effect, we do not test for the other two causal paths via which domestic rivalry may lead to international exports. For instance, we do not know to what degree a change in domestic-network size is due to a change in domestic competition – we simply hold constant domestic-network size. Accordingly, work that attempts to nest all three rivalry effects in an econometric treatment would be of merit. Second, as implied by our theoretical analysis, the greater the competitive response following increased domestic rivalry, the greater the international-market-share gain. A number of factors might influence the intensity of the competitive response, thus mediating the enhanced-performance of competitors effect. For instance, the domestic institutional environment (e.g., degree of domestic deregulation, extent of firm ownership by the state) might alter the impact of rivalry on exports; also, the relatedness of the domestic and international markets might effect the domestic-rivalry/export connection. Accordingly, further theoretical and empirical work that attempts to understand moderating factors would be of merit. Third, empirical testing beyond the airline industry would be merited; though, cross-industry studies may have reached their limit with respect to yielding additional insights. We think that firm-level analysis – as in this exercise – holds the potential for better teasing out the different paths via which domestic rivalry might influence exports.

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Table 1: Variable Definitions and Sources

Variable Name	***Definition***	***Source***
International-Market-Share	Airline's share of revenue passengers in the focal international country-pair market.	TFS
Domestic-Competitors	Number of firms competing in airline's home-domestic market.	TRF
Domestic-Market-Share	Airline's share of the revenue passengers in its home-domestic market.	TRF
Domestic-Network	Airline's number of domestic departures in its home-domestic market.	TRF
Merger	Dummy variable coded 1 for the year and subsequent years of an airline's first domestic merger over the 1984-1992 period	Clougherty 2002, 2006
International-Rivalry	Average number of competitors an airline faces in its various international country-pair markets.	TFS
Domestic-Competitor-Network	Number of domestic departures for the competitors an airline faces in its home-domestic market	TRF
Home-Competitors	Number of home-based competitors in the international country-pair market	TFS
Foreign-Competitors	Number of foreign-based competitors in the international country-pair market	TFS

- TRF = ICAO's Traffic Series
- TFS = ICAO's Traffic by Flight Stage Series

TABLE 2: Descriptive Statistics—Domestic Merger Activity, Number of Observations & Variable Means by Airline										
			Variable Means							
Airlines	*Year of 1st Merger*	# of Obs.	International-Market-Share	Domestic-Competitors	Domestic-Market-Share	Domestic-Network	International-Rivalry	Competitor-Domestic-Network	Home / Foreign Competitors
AerlArgentinas	1990	8	36.81	5.00	63.94	53562	2.56	42832	0.00 / 1.75
AeroMexico	--	10	10.63	2.00	45.10	60705	3.79	60869	1.00 / 7.90
Air Canada	--	48	39.26	3.67	48.50	111438	3.60	147340	0.71 / 3.33
Air France	1988	118	43.94	6.79	14.62	23940	2.96	156542	0.14 / 2.05
Air UK	--	26	9.32	22.46	9.32	34033	4.56	191050	3.27 / 1.08
AirNewZealand	--	16	48.93	1.00	100	43048	2.54	0	0.00 / 1.63
Alitalia	--	124	46.76	3.36	37.08	47471	2.26	88955	0.16 / 1.44
American	1987	62	11.98	25.55	15.77	747061	5.92	5216265	6.53 / 1.94
Brit Airways	1987	136	44.43	24.28	57.10	83293	4.04	154121	1.69 / 1.77
Brit Caledonia	--	22	4.16	13.55	6.30	9615	5.18	151654	3.00 / 2.18
Brit Midland	--	24	9.17	23.17	18.99	38593	5.12	190937	3.25 / 1.08
Britannia	1988	4	12.37	24.00	0.56	620	4.25	235287	3.5 / 1.00
Canadian	1986	42	43.27	3.33	46.20	113986	2.74	137944	0.29 / 3.10
Continental	1986	52	15.91	25.19	7.83	450450	7.55	5513583	5.31 / 1.62
Cruziero	--	2	26.40	9.00	18.45	45705	3.00	324552	1.00 / 1.00
Delta	1986	52	9.75	26.12	15.83	841395	6.11	5126570	6.67 / 1.96
Eastern	--	12	5.38	29.25	5.22	267961	6.95	5715313	7.83 / 2.00
Finnair	--	43	60.84	3.00	78.90	33668	1.52	24427	0.00 / 1.05
Iberia	--	114	50.06	2.70	65.64	96722	2.49	73704	0.19 / 1.71
JAL	--	54	37.82	6.52	23.55	52581	2.84	339878	0.52 / 2.09
KLM	1988	108	59.28	1.98	96.82	3980	2.32	338	0.00 / 1.73
Ladeco	--	14	21.38	5.57	48.63	11206	2.61	13647	0.71 / 1.29
LanChile	--	4	28.77	5.00	42.97	9529	3.00	12899	1.00 / 1.50
Lufthansa	--	138	49.29	2.54	98.25	138856	2.78	6769	0.34 / 1.83
Mexicana	--	4	40.76	2.00	61.65	57005	10.00	46483	1.00 / 8.00
Northwest	1986	56	11.03	26.86	8.14	476803	7.36	5503213	6.18 / 1.82
Olympic	--	92	46.68	1.00	100	55758	2.04	0	0.00 / 1.11
PanAm	--	72	19.00	28.99	1.67	76798	5.23	5922437	3.96 / 1.61
Qantas	1992	32	50.98	0	0.00	0	2.85	184212	0.00 / 2.00
SwissAir	1991	78	56.44	2.00	74.82	19177	2.36	12185	0.12 / 1.50
TAP	--	36	54.77	2.00	80.91	16047	2.15	8085	0.06 / 1.42
TWA	1986	93	18.13	27.18	4.89	273722	5.65	5709359	3.28 / 1.32
United	--	48	16.62	26.42	12.92	628285	6.33	5360362	5.71 / 1.71
US Air	1987	14	9.20	26.57	11.00	758732	8.81	5206735	8.57 / 2.00
UTA	--	8	2.39	0	0.00	0	7.08	183250	1.00 / 7.13
Varig	--	108	43.46	9.48	30.81	77722	2.14	307610	0.09 / 1.19
Virgin	--	15	5.90	0	0.00	0	4.91	228681	2.13 / 5.20
All Airlines		1889	37.35	11.45	44.68	158876	3.68	1426286	1.69 / 1.80

Table 3: Regression Results

- Dependent Variable (Y): International-Market-Share
- All Regressions include fixed period-effects.

Explanatory Variables	Regression #1: Random Effects	Regression #2: Fixed Effects	Regression #3: GMM, Instrument for Lagged Y Variables	Regression #4: GMM, Instrument for all Potentially Endogenous Variables
Domestic-Competitors	0.050*** (0.019)	0.064** (0.028)	0.114* (0.067)	0.051** (0.025)
Domestic-Market-Share	0.061*** (0.011)	0.070** (0.032)	0.014 (0.015)	0.031*** (0.009)
Domestic-Network (mlns. of dom. departures)	4.91*** (1.53)	15.1*** (3.23)	30.0** (14.6)	4.67*** (1.21)
Merger	1.15** (0.51)	0.34 (0.68)	0.46 (1.92)	1.61** (0.71)
International-Rivalry	-0.73*** (0.22)	-0.93*** (0.30)	-1.28*** (0.50)	-0.46** (0.21)
Domestic-Competitor-Network (mlns. of dom. departures)	-57.6** (24.3)	1.27 (1.38)	-1.49* (0.80)	-50.4*** (15.8)
Home-Competitors (natural log)	-2.64*** (0.43)	-2.16*** (0.52)	-7.26** (3.04)	-2.39** (0.98)
Foreign-Competitors (natural log)	-2.44*** (0.54)	-2.34*** (0.91)	3.07 (2.36)	-1.45** (0.65)
International-Market-Share $_{t-1}$	0.685*** (0.045)	0.501*** (0.049)	0.738*** (0.088)	0.863*** (0.065)
International-Market-Share $_{t-2}$	0.027 (0.040)	-0.037 (0.040)	-0.036 (0.041)	-0.057 (0.038)
Constant	12.75*** (1.80)	18.47*** (3.03)	12.44*** (4.01)	8.64*** (3.19)
R-square	0.92	0.79		
Observations	1889	1889	1889	1889
Arellano.Bond test that average auto covariance in residuals of order 2 is 0			z = -0.43 Pr > z = 0.670	z = 0.10 Pr > z = 0.918
Difference-in-Hansen tests of exogeneity of instrument subsets:				
• instruments for levels-equation			Prob > chi2 = 0.692	Prob > chi2 = 0.173
• additional instruments			Prob > chi2 = 0.016	Prob > chi2 = 0.390

( ) = Robust or Corrected Standard Errors; *** = 1% Signif, ** = 5% Signif, * = 10% Signif

APPENDIX A

1. ***Assumptions*****:** We consider downward-sloping demands: $p_x^x(X,Y)(\equiv \partial p^x(X,Y)/\partial X) < 0$, $p_y^y(X,Y) < 0$, $\hat{p}_x^x(\hat{X},\hat{Z}) < 0$ and $\hat{p}_z^z(\hat{X},\hat{Z}) < 0$. Assume the outputs of competing firms are (imperfect) substitutes: i.e., $p_y^x(X,Y) < 0$, $p_x^y(X,Y) < 0$ in the domestic market; and $\hat{p}_z^x(\hat{X},\hat{Z}) < 0$, $\hat{p}_x^z(\hat{X},\hat{Z}) < 0$ in the international market. Following standard practice in models of quantity competition, we further assume that in each market, the outputs are 'strategic substitutes': i.e.,

$$p_y^x + (X/n)p_{xy}^x < 0,\; p_x^y + (Y/m)p_{yx}^y < 0,\; \hat{p}_z^x + (\hat{X}/n)\hat{p}_{xz}^x < 0,\; \hat{p}_x^z + (\hat{Z}/f)\hat{p}_{zx}^z < 0. \quad \text{(A1)}$$

In addition, we assume

$$(n+1)p_x^x + Xp_{xx}^x + \beta_x < 0, \quad (m+1)p_y^y + Xp_{yy}^y < 0, \quad (n+1)\hat{p}_x^x + \hat{X}\hat{p}_{xx}^x + \hat{\beta}_x < 0,$$

$$(f+1)\hat{p}_z^z + \hat{Z}\hat{p}_{zz}^z < 0 \quad \text{(A2)}$$

which, together with (A1) and the stability conditions below, form the conditions for the existence and uniqueness of the multi-market Cournot equilibrium (e.g., Zhang and Zhang, 1996).

2. Proof of Proposition 1**:** (a) Since within each of the three groups firms are symmetric in demand and cost, at equilibrium $x_i = X/n$, $y_j = Y/m$, $\hat{x}_i = \hat{X}/n$ and $\hat{z}_k = \hat{Z}/f$. We aggregate the individual first-order conditions over the *n*, *m* and *f* firms respectively, yielding

$$\Pi_X^X(X,Y,\hat{X}) \equiv p^x + \frac{p_x^x}{n}X - \alpha_x + \frac{\beta_x}{n}X + \frac{\theta}{n}\hat{X} = 0,\; \Pi_Y^Y(X,Y) \equiv p^y + \frac{p_y^y}{m}Y - \alpha_y = 0,$$

$$\Pi_{\hat{X}}^{\hat{X}}(X,\hat{X},\hat{Z}) \equiv \hat{p}^x + \frac{\hat{p}_x^x}{n}\hat{X} - \hat{\alpha}_x + \frac{\theta}{n}X + \frac{\hat{\beta}_x}{n}\hat{X} = 0,\; \Pi_{\hat{Z}}^{\hat{Z}}(\hat{X},\hat{Z}) \equiv \hat{p}^z + \frac{\hat{p}_z^z}{f}\hat{Z} - \hat{\alpha}_z = 0. \quad \text{(A3)}$$

These equations jointly determine the equilibrium ($X, Y, \hat{X}, \hat{Z}$). In the absence of a rivalry rationale, totally differentiating (A3) with respect to *m* yields (subscripts again denoting partial derivatives),

$$\begin{bmatrix} \Pi^X_{XX} & \Pi^X_{XY} & \Pi^X_{X\hat{X}} & 0 \\ \Pi^Y_{YX} & \Pi^Y_{YY} & 0 & 0 \\ \Pi^{\hat{X}}_{\hat{X}X} & 0 & \Pi^{\hat{X}}_{\hat{X}\hat{X}} & \Pi^{\hat{X}}_{\hat{X}\hat{Z}} \\ 0 & 0 & \Pi^{\hat{Z}}_{\hat{Z}\hat{X}} & \Pi^{\hat{Z}}_{\hat{Z}\hat{Z}} \end{bmatrix} \begin{bmatrix} X_m \\ Y_m \\ \hat{X}_m \\ \hat{Z}_m \end{bmatrix} = \begin{bmatrix} 0 \\ -\Pi^Y_{Ym} \\ 0 \\ 0 \end{bmatrix}. \tag{A4}$$

To examine the impact of *m* on exports, we solve (A4) and obtain $\hat{X}_m = -\Pi^{\hat{Z}}_{\hat{Z}\hat{Z}} \Pi^{\hat{X}}_{\hat{X}X} \Pi^X_{XY} \Pi^Y_{Ym} / \Delta$, where Δ is the determinant of the 4-by-4 matrix in (A4) and is positive by the multi-markets stability conditions (e.g., Zhang and Zhang, 1996). Further, we have $\Pi^X_{XY} = p^x_y + (X/n) p^x_{xy} < 0$ by (A1), $\Pi^{\hat{Z}}_{\hat{Z}\hat{Z}} = ((f+1)\hat{p}^z_z + \hat{Z}\hat{p}^z_{zz})/f < 0$ by (A2), and $\Pi^Y_{Ym} = -Yp^y_y / m^2 > 0$. Therefore, $\hat{X}_m$ has the opposite sign to that of $\Pi^{\hat{X}}_{\hat{X}X} = \theta / n$, or θ. Part (a) of Proposition 1 then follows by further noting that $\Pi^Y_{YY} = ((m+1)p^y_y + Yp^y_{yy})/m < 0$ by (A2) and hence $Y_m = -(1/\Pi^Y_{YY})(\Pi^Y_{YX} X_m + \Pi^Y_{Ym}) > 0$.

(b) Under the rivalry hypothesis, the export effect of rivalry can be obtained by differentiating (A5),

$$\Pi^X_X(X, Y, \hat{X}; r(m)) \equiv 0,\ \Pi^Y_Y(X, Y; m) \equiv 0,\ \Pi^{\hat{X}}_{\hat{X}}(X, \hat{X}, \hat{Z}; r(m)) \equiv 0,\ \Pi^{\hat{Z}}_{\hat{Z}}(\hat{X}, \hat{Z}) \equiv 0 \tag{A5}$$

with respect to *m*, where $X, Y, \hat{X}, \hat{Z}$ denote the equilibrium quantities. The expression is as follows:

$$\hat{X}_m = (-\Pi^{\hat{Z}}_{\hat{Z}\hat{Z}} / \Delta)\left(\Pi^{\hat{X}}_{\hat{X}X} \Pi^X_{XY} \Pi^Y_{Ym} - \Pi^Y_{YY} \Pi^{\hat{X}}_{\hat{X}X} \Pi^X_{Xm} + \Delta_1 \Pi^{\hat{X}}_{\hat{X}m}\right). \tag{A6}$$

The first term on the RHS of (A6) has been discussed in (a). In the absence of joint-economies, $\theta = 0$; consequently, $\Pi^{\hat{X}}_{\hat{X}X} = 0$ and so the first two terms in (A6) vanish. Since $\Pi^{\hat{X}}_{\hat{X}m} = (\hat{p}^x_r - c_{\hat{x}r}) r'(m) > 0$ by (1) and $\Delta_1 > 0$ by stability of the sub-market (Δ_1 is the determinant of the top-left 2-by-2 sub-matrix of the matrix in (A4)), it follows that $\hat{X}_m > 0$. Moreover, from (A4), $\hat{Z}_m = -(\Pi^{\hat{Z}}_{\hat{Z}\hat{X}} / \Pi^{\hat{Z}}_{\hat{Z}\hat{Z}}) \hat{X}_m$. Since $\Pi^{\hat{Z}}_{\hat{Z}\hat{X}} = \hat{p}^z_x + (\hat{Z}/f)\hat{p}^z_{zx} < 0$ by (A1), $\hat{Z}_m$ has an opposite sign to that of $\hat{X}_m$ and hence the above result with respect to exports also extends to export market share. *Q.E.D.*