

Oligopoly in International Commodity Markets: the Case of Coffee Beans

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Abstract

This paper studies the impact of international market structure on commodity prices. I use a standard oligopoly model and exploit historical variations in the structure of the international coffee bean market in order to measure how successful a cartel treaty was and to assess its global welfare consequences. The results suggest that the International Coffee Agreement (ICA, 1965–89) raised price by 73 percent, annually transferring approximately 8 billion dollars from consumers to exporting countries, and its lapse in 1989 explains four-fifths of the subsequent price decline. I then discuss implications for public policies and the analysis of other international commodity markets.

1 Introduction

Despite its caffeine content, coffee can cause depression. Between 1988 and 2001, the price of coffee beans fell by 75 percent to an 89-year low of 50 cents per pound (see Figure 1),¹ with exporting countries and producers around the globe suffering the consequences.² Historically, there have been numerous crises caused by drops in commodity prices. Although

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¹Spot price (Brazilian and Other Arabica) at the New York Board of Trade, adjusted by US-CPI to the 2007 constant U.S. dollar. The 89-year low refers to the period since the beginning of price data in 1913.

²The “coffee crisis” affected over 25 million farmers around the globe (Clark 2007, p.169). Between 1988 and 1994, real GDP grew by only 0.96% annually in countries where coffee was the major export, whereas the

the effects of these crises are well documented, few studies have analyzed their causes, which policymakers need to understand in order to alleviate the consequences. At the heart of this gap lies the common belief that commodity prices are volatile and hence unpredictable,³ which is not necessarily true. Also contrary to popular belief, cartels and other forms of imperfect competition are prevalent in the market structures for many commodities traded on international exchanges. This paper studies the impact of international market structure on commodity prices.

(Figure 1 here)

The purpose of this paper is threefold: (1) to understand the price determination mechanism in international commodity markets, (2) to measure market power embodied by an international cartel treaty, and (3) to assess its global welfare impacts. For these purposes, I have chosen to study the coffee bean market, which is interesting and important in itself, but focusing on this commodity has other merits. First, of all price movements within primary commodities, that of the coffee bean is one of the most sensitive to the economic fundamentals of short-run supply and demand. By contrast, commodities such as crude oil and metals are storable and require a decade-long technological extraction process that entails much uncertainty. Second, the coffee cartel was simple in that it was based on an export quota system. This feature allowed my analysis to focus on price, cost, and export quantities. Other international commodity agreements, in contrast, often employ more complex rules such as buffer stock inventories, which would materially complicate the analysis without adding significant insight. Third, with 55 exporting countries around the globe and trading volume second only to crude oil, the coffee bean could be called a “representative agent” of international commodity markets. It is hoped that some of the insights gained from this market can be carried over to other international commodity markets. Finally, some producing countries rely on the coffee bean for more than half of their entire export revenues (e.g., El Salvador and Uganda). Hence, the coffee price could be called their real exchange rate, fluctuations of which are tantamount to true macroeconomic shocks. These features render the study of the coffee bean industry particularly fruitful.

In this paper, changes in market structure explain one of the most prominent commodity crises in recent history: the “coffee crisis.” I have separately identified the price effects of

figure was 3.19% for non-coffee exporters. The ensuing waves of sovereign debt cancellations cost taxpayers over \$162 billion in richer countries (total debt relief for 51 coffee exporting countries, 1990–2007). The 55 exporting countries I analyze in this paper constitute 42% of all developing countries and 59% of “highly indebted poor countries” (HIPC). The plight of the coffee industry fueled the intensifying violence in Colombia (Dube and Vargas 2009) and exacerbated ethnic tensions in Rwanda, where coffee accounted for 57% of all exports (Verwimp 2003).

³In the aftermath of the coffee crisis, some analysts noted, “Given the speculative nature of commodity markets it is difficult to attribute price changes to a sole source” (Giovannucci et al. 2004, p.xiv).

(1) the breakdown of the international cartel agreement in 1989, (2) Vietnam’s emergence as a major exporter during the 1980s and 1990s, and (3) weather and other shocks to supply and demand. To identify these effects, I exploit two historical changes in the structure of the international coffee bean market. First, both the rise and fall of the international cartel agreement (the International Coffee Agreement: ICA, 1965–89) owe much to U.S. foreign policies motivated by Cold War geopolitics rather than internal market forces. Second, the rise of Vietnam as a major exporter since the late 1980s represents one of the rare successes of a developmental “big push” as distinct from the game-theory textbook case of a strategic new entrant to the market. In addition, the major source of the price volatility—weather shocks disrupting supply, in particular frosts and droughts in Brazil—is observed and controllable. As a preliminary data analysis, I regress the coffee price on explanatory variables representing these factors (i.e., ICA, Vietnam, and weather) along with other control variables. This reduced-form analysis informs us about the likely price impact of each of these forces and clarifies the sources of identification for the subsequent structural analysis.

I then proceed to develop an estimable model of the international coffee bean market for three reasons: (1) a large body of relevant economic theory exists, which would help us understand this market in terms of demand, supply, and market power; (2) an oligopoly model would facilitate our measurement and interpretation of market power; and (3) a structural model would allow us to quantify the global welfare impacts of the international cartel treaty. The estimation and simulation results suggest that the ICA’s market power was far from what a monopolist would have achieved, but still it managed to raise price by 73% on average, embodying an annual transfer of approximately 8 billion dollars from the developed economies to the exporting countries. This sum of wealth is equivalent to 13% of the world’s total Official Development Aid (ODA) and therefore economically significant. The results also suggest that the breakdown of ICA in 1989 could explain four-fifths of the subsequent drop in coffee prices—a result that matches the reduced-form estimates, which is reassuring for the reliability of the other structural estimates.

I have organized the rest of the paper as follows. The remainder of this section documents three distinct literatures that motivated this study. Section 2 summarizes the institutional and historical background of the international coffee bean market. Section 3 explains the dataset and shows the results of preliminary data analysis. Section 4 describes the model of the coffee export market. Section 5 reports the estimation results. Section 6 presents welfare analysis of the cartel treaty and decomposition of the “coffee crisis.” Section 7 concludes. In the Appendix, I discuss an alternative explanation of the coffee crisis from the demand side.

1.1 Related Literature

Many of the basic inputs to our economies are traded in international commodity markets, such as food and energy, but relatively little is known about their price determination mechanisms.

An extensive body of work across agricultural, development, and financial economics studied certain aspects of the international commodity markets (see Deaton 1999 for an overview), such as the time-series properties of commodity prices and the impacts of price fluctuations on rural households. But these studies tend to abstract from the fundamental forces of demand and supply, and usually assume perfect competition, which, by construction, rules out market power as an explanation.⁴

However, a closer look at the supply side and the institutional features of these markets suggests that cartels and oligopolies are prevalent. For example, Slade and Thille (2006) investigated cartel arrangements in the base metals markets (aluminum, copper, lead, nickel, tin, and zinc).⁵ Imperfect competition models have long been applied to the study of international trade, but most often in the context of analyzing particular domestic markets for manufactured goods, and with more emphasis on strategic trade policies than market power *per se*.⁶

⁴This literature has documented the welfare *consequences* of commodity price movements for national economies (e.g., Catão and Sutton 2002) as well as rural households (e.g., Varangis et al 2003), but few studies have analyzed the *determinants* of commodity prices. This omission reflects the tendency of analysts to assume perfect competition, taking price fluctuations as random shocks (e.g., Akiyama and Varangis 1990, Mehta and Chavas 2008). Exceptions are Karp and Perloff (1989, 1993), although their main objective was to test particular dynamic oligopoly models. In contrast, this paper focuses on estimating market power and its price impacts.

⁵Cartel and imperfect competition are the norm rather than the exception in many commodity markets. Even when individual producers at the sub-national level are atomistic, exporting institutions and international agreements often create a virtual oligopoly of several nations at the international level. For example, OPEC controls a sizable proportion of the world's crude oil exports. De Beers exercised monopoly power over the diamond market. Spar (1994) analyzes international cartels in the markets for diamonds, uranium, gold, and silver. Stocking and Watkins (1946) document the prevalence of cartels in the markets of sugar, rubber, nitrogen, steel, aluminum, magnesium, and various chemical products in the first half of the 20th century, and Gilbert (1996) presents a historical assessment of the international commodity agreements on cocoa, coffee, rubber, sugar, and tin in the second half of the century.

⁶For example, Brander and Spencer (1985), Eaton and Grossman (1986), and Helpman and Krugman (1989) theoretically analyzed the strategic uses and welfare implications of tariffs, anti-dumping, quotas, and subsidies. Corresponding empirical works have measured and evaluated the actual effects of these trade policies (e.g., Berry, Levinsohn, and Pakes 1995, 1999; Feenstra and Levinsohn 1995; Goldberg 1995). My research follows their footsteps in applying an IO model to international trade, but with a different emphasis: countries, not companies, competing and cooperating in the product market.

More recent papers on state trade enterprises (STEs) studied a similar situation in which exporting or importing decisions are made at the national government level (e.g., Hamilton and Stiegert 2002; Dong, Marsh, and Stiegert 2006; and McCorrison and MacLaren 2010). Whereas these studies focused on the rent-shifting effects in the strategic trade context, this paper aims to address a different issue: the measurement of market power and its price effects.

In this paper, I propose to analyze market power in one of the largest international commodity markets (coffee) and one of the simplest cartel agreements (ICA). To do so, I build on a combination of standard oligopoly models and lessons from the existing studies of cartels in the IO literature.⁷ A central dilemma for any study of collusion is that, even though such cooperative behaviors are intrinsically dynamic, fully dynamic models of collusion are difficult to identify.⁸ This paper’s approach is to bypass the issue by carefully selecting a case and dataset that can be consistently studied within static frameworks,⁹ with the goal of providing a first step toward deeper understanding of price determination in international commodity markets, the role played by market structure, and how the latter may evolve in the long run.

In summary, the international commodity markets represent important gaps both within and between these bodies of economic literature, which this study aims to fill.

2 The International Coffee Bean Market

This section provides the institutional background of the international coffee bean market. First I describe the profiles of coffee importers and exporters, as well as product characteristics. Then I explain the historical context of the cartel treaty and fringe competitor, which is crucial for understanding the geopolitical nature of the changes in market structure. Specifically, I argue that both the rise and fall of the international cartel agreement, as well as

Finally, this paper shares with that of Bagwell and Staiger (1990) the characterization of countries as strategic competitors. However, while they applied the tacit collusion model to explain “managed trade,” I focus on measuring the effectiveness of an explicit collusion based on an international treaty.

⁷Bresnahan (1982) pioneered the estimation of market power, followed by numerous applications. See Bresnahan (1987) on automobile, Brander and Zhang (1990) on airline, Graddy (1995) on fish, Parker and Röller (1997) on mobile telephone, Genesove and Mullin (1998) on sugar, Wolfram (1999) and Puller (2007) on electricity, and Clay and Troesken (2003) on whiskey. The identification conditions for Bresnahan’s estimation approach are discussed in Lau (1982), Corts (1999), and Perloff and Shen (2001).

Genesove and Mullin (1998) cross-validated his estimated markups with directly observed measures. More recent contributions examined more complicated competitive environments. Röller and Steen (2006) studied the effectiveness of a legal cartel in the Norwegian cement market. Salvo (2010) considered a situation in which the threat of import competition limited the domestic oligopoly’s market power. He extended the framework by modeling latent imports as a competitive fringe. I have shared the spirits of these two papers, in structurally analyzing the market power of an explicit cartel, in the presence of a competitive fringe.

⁸Classical works include Porter’s (1983) and then Ellison’s (1994) studies of the railroad cartel. More recent papers (e.g., Fershtman and Pakes 2000, de Roos 2004) simulated dynamic oligopoly models with *tacit* collusion. Meanwhile, few studies focus on *explicit* collusions, i.e., cartel arrangements where agreements are explicitly stated and enforced. A rare exception is Röller and Steer (2006), who emphasized the importance of measuring the effectiveness of a particular cartel arrangement. My study contributes to this strand by measuring the actual market power of an explicit international cartel treaty, in a way that is structurally interpretable.

⁹Hence this paper shares the spirit of Asker (2010) in exploiting situations where external evidence exists on the exact functionings of cartels.

the expansion of Vietnamese exports, were out-of-the-blue shocks to the export market, thus providing the econometrician with rich *exogenous* variations in data. Moreover, because the variations were direct reflections of U.S. foreign policies and Vietnam’s rural development projects, the subsequent empirical analysis is informative regarding public policies in competition, trade, and aid. Finally, weather shocks are another source of exogenous variations in data, which I explain in Section 3 and use as an instrument for demand estimation in Section 5.

2.1 Importers, Exporters, and Product Characteristics

Americans drink, on average, 1.76 cups of coffee a day, whereas Europeans down 2.04 cups. Even the green-tea-loving Japanese enjoy 1.42 cups of coffee.¹⁰ Together, the capitalist “first world” imported over 90 percent of the global coffee bean harvest in the sample period (1960–2006). Most of these countries (except for New Zealand and Israel) were “importing members” of the ICA. Their customs officials ensured that shipping carried the ICA’s stamp of approval, thereby monitoring and enforcing the exporters’ quota allocation. In essence, the ICA was a form of development assistance from the “first world” (see section 2.2 for details).

The socialist “second world,” or “non-member market,” imported approximately 5 percent of all coffee beans.¹¹ This market was composed of fringe buyers and formed the unregulated “black” market. Transactions in this market were not systematically recorded, but evidence suggests that black-market prices were 30 percent to 40 percent lower than in the regulated market. This price level was roughly equal to the domestic farm-gate/wholesale prices in exporting countries. This finding implies marginal cost pricing by exporting countries, which is not surprising because they customarily dumped excess harvest (supply above quota) to the socialist bloc. Thus the “second world” played the role of the buyer of last resort, or a safety valve, for the “third-world” farmers.¹²

To satisfy these peoples in the “North,” the “South” exports over \$10 billion worth (or 80 million 60kg bags) of green coffee beans every year. Coffee cultivation requires tropical highlands, thereby determining the producing regions. No significant entry or exit has occurred since the 1960s, aside from the rise of Vietnam.¹³ Fifty-five countries across Africa,

¹⁰Calculation based on the International Coffee Organization’s 2005 survey. I follow America’s National Coffee Association to equate an annual consumption of 1 kilogram with 0.42 cup per day (6.5 gram per cup).

¹¹They were outside the regime partly because they could not pay in hard currencies. See Bohman and Jarvis (1990) for a detailed account of the non-member market.

¹²The overall import quantity in the socialist bloc was limited to about 5% of the world’s total, so parallel imports (so-called “migrating coffee”—cheaper black-market beans being resold to the “first world”) were not a major issue.

¹³In this market, a country’s “entry” often meant national independence since most countries were former

Asia, and Latin America, with many small farms within each nation (see Figure 2), export coffee beans.

(Figure 2 here)

Government bodies in these countries, such as national coffee marketing boards, regulated the industry, which worked as a domestic planning/coordination agency. Since the international cartel agreement (an export quota system) worked at the supra-national level, my analysis focuses on nation states as the export decision makers, and particularly on their collective behavior in the global market.¹⁴

Green beans (coffee's raw material form before roasting, grinding, and brewing)¹⁵ are commonly classified into the following four categories in the world's commodity exchanges: Colombian Mild Arabica, Other Mild Arabica, Brazilian Natural Arabica, and Robusta. Like wine, coffee beans have subtle differences in aroma and taste by regions and even by farms. Such subtleties notwithstanding, the price movements of all four types are closely related, rarely deviating from $\pm 5\%$ range from each other's level, and with a correlation coefficient of over .93 (for monthly changes in prices). Another suggestive evidence is that there exists only one instrument in the trading of coffee futures, where a few adjustment rules (based on the countries of origin and delivery ports) are considered sufficient as contract specifications. Most importantly, the cartel's operation was based on the single indicator price (the weighted average of the four different coffee prices). Thus, to maintain consistency with the cartel's practice and to focus on the measurement of its market power, I followed previous studies (Karp and Perloff 1993, Nakamura and Zerom 2010) in characterizing green coffee beans as homogeneous goods.

colonies, which is why, aside from data availability, I focus on the years since 1960.

¹⁴Because this paper's main objective is international competition/cooperation and market power, I abstract from political economy at the sub-national level. See Bohman, Jarvis, and Barichello (1996) for rich institutional details.

¹⁵Coffee beans are storable in principle, but their hygroscopic nature (i.e., they attract and absorb moisture) makes them susceptible to moisture damage (i.e., mold and spoilage). Storage is costly also due to their low value relative to physical size. Hence only limited inventory exists, mostly for the purpose of smoothing logistics.

Regarding production dynamics, a coffee tree takes approximately five years to reach its full production potential. However, drastic changes are rarely observed in a country's production "capacities" (i.e., the number of coffee trees). Furthermore, shorter-run factors (trimming and fertilizers) alone may change the harvest quantity by as much as 50%. Thus issues of technological dynamics have limited implications.

2.2 The Cartel and the Cold War: Why the Rise and Fall of the International Coffee Agreement are Exogenous

Since the 1930s, coffee exporting countries had made many attempts to form a cartel-like arrangement, but none of those attempts survived. A successful quota scheme takes monitoring and enforcement, both of which were lacking. However, the situation changed after 1959, when Fidel Castro and his fellow guerrillas took power in Cuba: the Cuban Revolution. After frosty interactions with the United States, the revolutionary government turned to the Eastern bloc.¹⁶ Cuba was a coffee-producing economy, and the revolutionary movement gained momentum from the countryside, just as Mao and Guévara had theorized and practiced. Given this development in the United States' backyard, the Kennedy administration's foreign policy prioritized the "fight against communism."

Diplomatic alliance was one tool. Sending monetary aid was another. To maintain a good relationship with coffee-growing countries, the White House decided to provide monitoring/enforcement for its southern neighbors' long-sought quota agreement. Thus the United States signed the ICA in 1962 and, after three years of negotiations in Washington, Congress approved the legislation for the customs inspection of "certificate of origin" (see below) in 1965.¹⁷ Other "Northern" governments (including Japan but not New Zealand or Israel) had already signed up.¹⁸

The ICA was kept in place between 1965 and 1989 for the purpose of maintaining high coffee prices. Its primary mechanism was export quotas, which were allocated across countries in proportion to their historical market share.¹⁹ These quotas were then revised up or down across the board in response to the movements of the indicator price. The decision-making at the International Coffee Organization (ICO), the ICA's administrative body, relied on voting by both the exporting and importing member countries. All major decisions required a two-thirds majority. The votes were also allocated proportional to countries' trade shares, so the largest exporters (notably Brazil and Colombia) as well as the United States held veto power.

The ICA used "certificate of origin" for the monitoring and enforcement of export quota. The importing members collected and returned these certificates to the ICO, so that all exports were publicly recorded. Penalties for excess shipments were imposed through the

¹⁶See Domínguez (1978) for the political economy of revolutionary Cuba.

¹⁷Thus the early 1960s cannot be clearly characterized as either a non-cartel or cartel periods. For this reason, this paper does not intend to analyze the beginning of the ICA. See Bates (1997), ch.5. Other obstacles to the analysis of the coffee market's earlier years include the changing identities of newly independent colonies and the lack of detailed data.

¹⁸European governments had similar interests in stabilizing African economies.

¹⁹See Bates (1997), ch. 6 for the details of the ICA's functioning.

deduction of these shipments from the following year's quota. Excess shipments in a second year were penalized by a doubling of the deductions in the next. A third violation would lead to the loss of voting rights and possible expulsion from the ICO.

In practice, the rules were leniently applied, and loopholes existed. For example, certificates of origin were not required for either imports from *non-member* countries (such as the socialist bloc, which comprised the perfectly competitive black market) or exports to the so-called "new markets" (i.e., countries in which coffee had not yet become a staple of consumption). The problem was that this "tourist" coffee could be re-exported to the "traditional" markets in the member countries. The ICA rules were gradually refined to prevent major deviations, but room for small-scale cheating remained. Political conflicts were also rampant. Since the details of data collection, monitoring, quota allocation, and the measures to close those loopholes affected countries differently, almost every aspect of the ICA's operation was controversial, which complicated its internal political processes.

Despite these shortfalls, the ICA was widely considered as one of the most successful commodity agreements in history. Cooperation among producers remained problematic, but the crucial support came from the importing members in the form of the monitoring and enforcement of quotas. It also helped that the United States used its other aid programs to offer inducements and sanctions. As Bates (1997) documents: "The U.S. government was intensely aware that the success of its broader development assistance programs in Latin America would be strongly affected by the success of the International Coffee Agreement." (p.146)

But the honeymoon between the first and third worlds ended abruptly in 1989, when the second world imploded. The collapse of its Cold War enemy, and with it the rationale for hurting American consumers through high prices under the ICA, led the United States to withdraw its support. The ICA ended on July 4, 1989.²⁰ Without American policing, none of the subsequent resuscitation efforts proved fruitful.

2.3 Geopolitics of Land, Labor, and Ethnicity: Why Vietnam's Expansion is Exogenous

Although in 1989 the developed world scrapped the subsidies the ICA embodied, the Vietnamese government was expanding coffee bean production on the back of foreign aid. After the U.S. exit from Saigon in 1975 and a fight against China in 1979, this war-torn country

²⁰During the late 1980s, Secretary of State George Shultz demanded all international commodity treaties be reviewed by the State Department's Division of Economic Affairs, staffed with economists from Chicago, who subsequently recommended the withdrawal from these treaties. See Bates (1997, ch.7) and Clark (2007, ch.6) for the details of this political process.

had received an investment from the Soviet bloc in the early 1980s to plant coffee trees. The communist world needed beans available for purchase without hard currency.²¹

In a series of five-year plans, the central planners orchestrated widespread internal migration that prepared land and labor for coffee production, but their motives were more geopolitical than economic. From the perspective of the post-war strategists, Vietnam faced three challenges. First, the new government needed to establish control over land abandoned during wars and to secure border areas with China, Laos, and Cambodia. Second, the planners viewed ethnic minorities as internal political threats, most of whom lived in the forested upland areas and had sided with the United States during the war. Third, the peasantry-backed revolutionary government suspected that their authority would be undermined by high and growing population densities in the urban areas of the Red and Mekong Deltas (Solem et al 2010).

One solution to these perceived problems was to encourage or coerce large numbers of Kinh (the majority ethnic population) to move from the north to the under-populated frontier zone of the Central Highlands, which turned out to be suitable for coffee cultivation (see map in Figure 3). The government designated these areas as New Economic Zones in which internal migrants produced coffee.²² The graph in Figure 3 shows that the population of the Central Highlands more than doubled between the mid 1980s and the turn of the century, from less than 2 million to over 4 million. A survey performed in 1998-1999 found that 89 percent of the population of the Central Highlands had not been born there (Duc 2002), which highlights the scale of the government-led migration.

(Figure 3 here)

In addition to these migration policies, the government adopted the Economic Renovation (*Doi Moi*) policy in 1986. This constituted economic reforms to create a “socialist-oriented market economy,” which allowed the establishment of an agricultural private sector. Part of *Doi Moi* was land reforms. The new Land Law of 1988 sought to grant land use rights to households. All land technically remained under the state ownership, but the second Land Law of 1993 further permitted individuals to trade their land use rights (Vuong 2001). The government promoted the expansion of coffee cultivation through subsidized land and loans,

²¹Even after the Berlin Wall fell and Soviet assistance was gone, Vietnam still had other donors, such as Japan, the World Bank, and the Asian Development Bank. American aid also resumed in 1991. See Library of Congress Federal Research Division (1987 and 2005), *Vietnam Country Study*; and Mark E. Manyin, (2005), “U.S. Assistance to Vietnam,” Library of Congress.

²²The region was previously populated by ethnic minorities such as Ede, Rong, Sedang, Tai, and Giarai, most of whom relied on swidden (or slash-and-burn) agriculture. These groups were also incentivized to abandon nomadic behaviors (and join coffee farming) by the Fixed Cultivation and Sedentarization Program (Doutriaux et al 2008, Ha and Shively 2008).

and it provided support for seedlings, fertilizer, irrigation, and agronomy (Giovannucci et al 2004). As a result, coffee production area grew five-fold in the 1990s (Figure 4), before it hit the geographical limit in the early 2000s.²³

(Figure 4 here)

Thus, the growth of Vietnam’s coffee bean production was primarily driven by the geographical expansion of *Doi Moi* policies, on the back of foreign aid and large-scale ethnic migration schemes. These policies, in turn, stemmed from the geopolitical concerns of the post-war central planners. Such historical developments do not necessarily preclude the importance of economic incentives. Certainly, the goal of *Doi Moi* was the gradual transition from central planning to a market-based economy. The planners promoted coffee because Vietnam could produce it cheaply for profitable export. For the purpose of subsequent econometric analyses, however, the crucial aspect of Vietnam’s modern history is that the growth of coffee production occurred for those idiosyncratic reasons in a series of five-year plans, and mostly in isolation from the year-on-year price fluctuations in the global market.²⁴ By the late 1990s, Vietnam had dethroned Colombia as the world’s second-largest exporter (with Brazil still the largest), putting further downward pressure on the price of coffee beans. The overall process of production growth would be best characterized as a (rare) success story of a developmental “big push.”

2.4 Summary of the Institutional Context

In summary, the international coffee bean market consists of the developed countries (as importers) and developing countries (as exporters). The latter enjoyed market power under the ICA (1965–89), the rise and fall of which were driven by the U.S. government’s Cold War concerns. The socialist bloc played the role of fringe importers, representing a small, unregulated market for exporters. The breakdown of the coffee cartel coincided with the emergence of Vietnam as a fringe exporter urged along by foreign aid, government-led migration, and market-oriented reforms. Thus both the cartel’s breakdown and Vietnam’s expanded exportation represent changes in market structure that are exogenous to the year-on-year price

²³The area under crop peaked in 2001 and slightly decreased thereafter. This drop reflects state farms’ retreat from unsuitable lands. In official statistics, several provinces on the periphery of coffee cultivation appear and then disappear around that time (Ministry of Agriculture and Rural Development). See also ICARD and Oxfam (2002).

²⁴The Vietnamese government had not entered coffee trade negotiations before reaching its geographical limit of production in 2001. Vietnam finally became a member of the International Coffee Organization (ICO) on May 7, 2002, and of the World Trade Organization on January 11, 2007.

fluctuations in the global market. These changes provide the econometrician with rich variations in data, along with weather shocks to exporting countries, which I explain in the next section.

3 Data

This section first describes the dataset. It then reports the preliminary data analysis, regressing the coffee price on changes in the market structure (i.e., the cartel’s breakdown and the emergence of the new exporter, Vietnam).

3.1 Variables

The dataset spans the period 1960–2006 and contains the measures of prices, costs, exports, changes in market structure, and three other variables for instrumentation and control, at the monthly frequency with a few exceptions (annual). Table 1 displays their summary statistics.

(Table 1 here)

First, I observed both the *international coffee bean price* (the benchmark price index calculated by the ICO based on the spot prices in NYBOT)²⁵ and the exporting countries’ *domestic farm-gate prices* (the prices the growers receive in these countries).²⁶ Because the latter reflect what exporters/governments pay the coffee growers, it represents the marginal cost of exporting.²⁷ Studies on the international “black” market (see section 2) suggest the

²⁵The ICO collects “ex-dock” prices, which include costs of transport and unloading from vessel at port of discharge. When such prices are unavailable, the ICO’s agents adjust FOB (i.e., pre-shipping) or CIF (i.e., post-shipping) prices to emulate ex-dock rates. Coffee beans are carried by either dry-bulk or container ships. Their freight rates are known to fluctuate over time, as reflected in the movements of Baltic Dry Index (BDI, for dry-bulk ships) and HARPEX (for container ships) partly because they include Bunker fuel costs, which co-move with crude oil prices. As a result, our measure of selling prices contains some noise, but I chose to use this series without further adjustment for three reasons. First, both BDI and HARPEX date back to the mid-1980s at most, so we cannot use them for over a half of our sample period. Second, shipping costs represent only a small fraction of the coffee price (5.4% according to Yeats 1995, p.24, Table 8), hence unlikely to alter our conclusions about the 70% decline of the latter. Third, BDI moved within a relatively narrow range during the 1980s and 1990s and then rose sharply between 2000 and 2008, hence this *upward* trend seems unlikely to have caused a *downward* shift in the coffee price.

²⁶I use the market-share-weighted average of the farm-gate prices across countries, but all of the subsequent results are robust to other aggregation rules such as simple averaging or using only the top producers like Brazil and Colombia.

²⁷This interpretation can be supported by at least three models of an exporting country’s domestic economy: (1) the domestic wholesale coffee bean market is competitive; (2) the government/exporter acts as a benevolent social planner for the entire domestic economy; and/or (3) the government/exporter acts as the representative of the coffee producers by first paying them the marginal cost of production and then

prevailing price in that unregulated, perfectly competitive market equals those farm-gate prices in exporting countries. This is yet another way in which the farm-gate price (\approx the black-market price) reflects the opportunity cost (marginal cost) for a country to export to the ICA-member (i.e., regulated) market. Given these data, I was able to measure exporters' market power by *markup* (price-cost margin, or the Lerner index): $m_t \equiv \frac{P_t - mc_t}{P_t}$.

Second, I examined the exports of coffee by country. Three quantities are particularly important for the subsequent analyses: *world exports*, *cartel members' collective exports*, *Vietnam's export* (denoted by Q_t , Q_t^C , and q_t^V , respectively). This q_t^V reflects the sudden acceleration of the Vietnamese production, a government-led "big push" (see section 2.3 for the institutional background). Together with q_t^V , the *cartel breakdown dummy* (which equals zero before July 1989 and one since then) represents changes in the market structure due to the end of the Cold War (see section 2.2 for details).

Another important variable is *weather shocks*, W_t . In the spirit of Roll's (1984) analysis of orange juice and weather, I use weather shocks as an instrument for the price in demand estimation (see section 5). Weather is the most important shock for coffee production. The trade publication *The CRB Commodity Yearbook* contains news on events that influence commodity prices, from which I collected the record of major frosts and droughts in producing countries, most importantly Brazil, as well as Central America, East Africa, and South East Asia. These records were then cross-checked with the ICO's record of major frosts and droughts. Since damaged coffee trees usually take two years to recover, I coded each of the 24 months (since each of the weather shocks) as a time dummy variable.²⁸ When multiple shocks overlap within 24 months from each other's occurrence, I code the second and (at most) third shocks in separate sets of time dummies because each additional shock does affect price at least as much as the first one.

Other shocks on the demand side will serve as control variables. Developed economies' aggregate *real GDP*, X_t , embodies both population and per-capita income of the importing countries. Since the world coffee demand grew roughly proportional to the size of population, this variable effectively detrends the demand. Finally, the *real price of tea*, Z_t , would control for a potential substitution of tea for coffee.²⁹ The inclusion of these variables is informed

transferring the export surplus to the producers as well. See Bohman, Jarvis, and Barichello (1996) for the various models of exporting countries' domestic market structure that are consistent with this interpretation.

²⁸The estimation results are robust to changes in the way I code the weather variable, including different treatments of the instances of multiple frost/drought shocks.

²⁹The tea price is suitable as a control variable as it evolves independently from the developments in the coffee market for the following reasons. First, the climate zone for tea growing is different from that for coffee and subject to different weather shocks. Second, over half of the tea production is for domestic consumption in places such as China, India, Sri Lanka, Bangladesh, and Japan, rather than for exports. Third, unlike the coffee trade, the international trade of tea is competitive except for the brief period during the Great Depression (i.e., outside my sample period). See Gupta (2001) for details.

by Karp and Perloff’s (1993) and Nakamura and Zerom’s (2010) studies of coffee demand.

Because mc_t , X_t , and export quantities are recorded only at the annual frequency, I convert them into monthly series by repeating each year’s observation (or a twelfth of it) for 12 months. This conversion would create a potential measurement error problem in regressions, which I will address with the monthly series of weather IVs in Section 5.

3.2 Preliminary Data Analysis

Those changes in the market structure reflect the geopolitical developments that are exogenous to the price fluctuations in the export market, so simple regressions could inform us about the determination of the coffee price. Such regressions will also clarify the basic sources of identification for the subsequent structural analysis. Thus, as a preliminary data analysis, I regress the coffee price, P_t , on those “shocks” to the market structure and controls:

$$P_t = b_0 + b_1 I_t \{Cartel\ Breakdown\} + b_2 q_t^V + b_3 W_t + b_4 X_t + b_5 Z_t, \quad (1)$$

where $I_t \{Cartel\ Breakdown\}$ is the indicator function that equals one from July 1989, q_t^V is the Vietnamese exports, W_t is a set of time dummies representing weather shocks, X_t is the importing countries’ GDP (population times per-capita income), and Z_t is the price of tea (arguably an important substitute for coffee).

(Table 2 here)

Table 2 shows the results of these regressions. First, the cartel’s breakdown in 1989 seems likely to be the primary cause of the coffee crisis, with big and measurable impacts exceeding 130 cents across all specifications. Second, the estimates of the Vietnamese export effect are also statistically significant and its likely magnitude ranges between 29.4 and 69.8 cents. Third, weather shocks are important as a control variable, which is consistent with various industry reports’ emphasis. Their inclusion materially improves the fit (columns [4], [5], and [6]). Finally, the other control variable (rich countries’ income and population, and the price of tea) carry expected (positive) signs.

The impact of the weather shocks deserves further discussion, as they will become instrumental in the subsequent analysis (Section 5). Because they are a set of numerous time dummies, I report their effects visually in Figure 5 rather than as parts of Table 2. These shocks, usually in the form of major frosts in the coffee growing regions of Brazil, induce (both economically and statistically) significant changes in coffee prices. Such frosts last for only a day or two, but the damages to coffee trees are prolonged for up to two years, which is exactly what Figure 5 reflects: the coffee price stays at an elevated level (more than 50–100

cents above the normal level) for at least 18 months. Since the mean coffee price is 242 cents in my sample, a major frost would typically raise it by 20–40%, thereby providing us with a key source of price/quantity variation for estimating coffee demand.

(Figure 5 here)

4 Model

The regressions in the previous section suggest the likely price impacts of the cartel breakdown and the emergence of Vietnam. In this section, I proceed to develop an estimable model of the international coffee bean market for three reasons. First, there is a large body of economic theory relevant to the analysis of price determination, which would help us deepen our understanding of the international commodity markets based on demand, supply, and market power. Second, a structural model of oligopoly would facilitate our measurement and intuitive interpretation of market power. Third, public policies and economic events of this magnitude (i.e., ICA and coffee crisis) should be assessed quantitatively to inform policy design in the future. A proper welfare analysis requires a model of demand, and the construction of benchmark counterfactuals further necessitates supply-side modeling. Thus, some structure and assumptions are needed to analyze price-elasticity of demand, market power, and welfare impacts.

For these purposes, I developed an estimable model of demand and supply for the coffee bean export market, which is parameterized by the cartel’s degree of coordination. The model also features Vietnam as a fringe competitor, reflecting the unique institutional context of its coffee-sector development (see Section 2.3).

4.1 Demand and the Timing of the Game

World demand $Q(P_t)$ determines the relationship between world exports, Q_t , and price P_t . Let $P(Q_t)$ represent the inverse demand function. Vietnam is a new, fringe exporter. To consistently measure the coordination among all of the other exporters (the cartel treaty members), one should subtract Vietnamese exports from global demand to calculate the net demand curve that cartel exporters face. More formally, the setup is as follows:

1. Every month t , the world demands coffee beans. The (inverse) demand schedule, $P(Q_t)$, is common knowledge. The aggregate supply, Q_t , consists of the Vietnamese export q_t^V and those from the other 54 countries collectively called “the cartel” Q_t^C : $Q_t = q_t^V + Q_t^C$.

2. The new, fringe producer, Vietnam, exports its entire harvest, q_t^V . This q_t^V is the result of government-led ethnic migration, the *Doi Moi* policy, and foreign aid, and was therefore determined independently (see section 2.3 for details).³⁰
3. Given $P(Q_t)$ and q_t^V , that is, given the demand curve *net of fringe supply*, the 54 cartel members decide their *collective* exports, Q_t^C .

Thus, the framework is a combination of Stackelberg and Cournot games. Its Stackelberg feature is that there are first and second movers although the first mover (Vietnam) represents a policy shock rather than an active, strategic player as in the standard case. The setup also has a Cournot component in the sense that the second mover is not a single decision maker but a *collection* of export quantity-setting competitors, whose coordination may not be perfect in practice.

4.2 The Cartel's Coordination

The collective exports, Q_t^C , reflects the cartel members' coordination (or lack thereof). Consider a Cournot model with N symmetric countries shipping coffee beans.³¹ Country i in month t chooses export, q_{it} , to maximize its profit:

$$\pi_{it} = P(Q_t^C, q_t^V) q_{it} - C(q_{it}, W_t), \quad (2)$$

where $P(\cdot)$ is the inverse demand function, Q_t^C is the sum of exports from all countries excluding Vietnam (i.e., $\sum_{i \neq V} q_{it}$), and $C(\cdot)$ is the cost function. The cost shifter W_t affects the marginal cost $mc_{it} = \partial C(q_{it}, W_t) / \partial q_{it}$. The first order condition of country i 's profit maximization is

$$P_t + \frac{\partial P}{\partial Q} q_{it} = mc_{it}; \quad (3)$$

hence

$$-(P_t - mc_{it}) \left(\frac{\partial P}{\partial Q} \right)^{-1} = q_{it}. \quad (4)$$

³⁰In principle, Vietnam can be alternatively modeled as a *strategic* first mover (i.e., q_t^V depends on $P(Q_t)$ and Q_t^C), although this assumption would be inconsistent with the historical facts. The final results do not change significantly even under this alternative assumption. I have chosen the baseline assumption of *nonstrategic* Vietnam because of the country's unique institutional context and because I can then maintain the time-consistent interpretation of the coordination parameter over time.

³¹I discuss considerations regarding the implications of this symmetry assumption in Section 5.2.

We can sum this equation across countries to obtain the relation

$$\mu_t \equiv (P_t - \overline{mc}_t) \frac{-\left(\frac{\partial P}{\partial Q}\right)^{-1}}{Q_t^C} = \frac{1}{N}, \quad (5)$$

where \overline{mc}_t is the average of the N countries' marginal costs. I defined the expression on the left hand side as the collusion (coordination, or conduct) parameter, μ_t . If the cartel exercises some market power above the Nash equilibrium (Cournot competition) price level, this parameter will be greater than the *actual* $1/N$ in data and approach 1 as the cartel's coordination becomes perfect (i.e., as their collective action more closely resembles a hypothetical monopolist's behavior). Thus, the collusion parameter μ_t maps the markup (and hence the price) into an *effective* number of symmetric-Cournot competitors. For these reasons, I interpreted μ_t as the structural parameter that represents the cartel countries' coordination level. The goal of the next section is to estimate its empirical counterpart to quantify what the cartel actually achieved.

Before moving on to the estimation of μ_t , let us consider why this static measure of market power is a sufficient statistic for the purpose of this study. As an alternative modeling approach, it would be interesting to consider a dynamic game within the ICA cartel, in the spirit of *tacit* collusion models. The ICA, however, is an *explicit* collusion regime that is *externally* enforced by the importing countries such as the U.S.³² Occasional episodes of cheating notwithstanding, an exporting country cannot deviate much from its allocated quota because the U.S. government and other importing countries monitored and enforced the quota agreement. Moreover, quota is annual and stable over years. Hence the actual functioning of the ICA leaves little room for truly dynamic strategic interactions, either in the form of repeated game or in terms of production capacity dynamics. Thus, in the institutional context under study, the static notion of market power (embedded in μ_t) is adequate for measuring the performance of the cartel treaty.³³ I estimate μ_t in the next section.

³²Therefore the level of μ_t during the ICA period is fixed by the developed countries' foreign policies. This observation motivates my assumption that μ_t is constant within each of the two subsample periods (before and after 1989).

³³Even if the cartel's market power had complicated dynamics, as suggested in Corts's (1999) critique of the estimation approach by Bresnahan (1982), one could still interpret the static parameter of market power, μ_t , as a logically consistent "reduced-form" representation of all of the possible dynamic interactions, under the assumption of a constant level of collusion. That is sufficient for the purpose of this paper, which is to quantify how successful the ICA was and to identify its price impact, in the geopolitical context that effectively sets μ_t at a constant level. See Section 5.2 for further discussions.

5 Estimation and Results

The goal of this section is to estimate the structural model of the previous section. This section first presents the demand estimates for coffee beans, which I then used to adjust the observed markup, m_t . This normalized measure of market power, μ_t , is directly interpretable as the *structural parameter of the ICA's coordination*, and will be useful for simulations in the next section.

5.1 Demand Estimates with Weather IV

Demand estimation provides the basis for the subsequent analyses. Table 3 shows the estimates based on the following linear form:

$$Q_t = \alpha_0 + \alpha_1 P_t + \alpha_2 X_t + \alpha_3 Z_t + \varepsilon_t, \quad (6)$$

where Q_t is the quantity demanded, P_t is the world price, X_t is the demand shifter (the importing countries' GDP, i.e., buyers' population times income per capita), Z_t is the price of tea leaves,³⁴ and ε_t is the unobserved shock.³⁵ This specification follows Karp and Perloff's (1993) earlier study on the coffee demand, and the results also are comparable to their work. Because P_t is originally recorded at the monthly frequency whereas Q_t (and X_t) is not, the actual estimation uses the following inverse demand function:

$$P = \frac{1}{\alpha_1} [Q_t - (\alpha_0 + \alpha_2 X_t + \alpha_3 Z_t + \varepsilon_t)], \quad (7)$$

(Table 3 here)

In Table 3, columns [1], [2], and [3] present the OLS estimates. In columns [4], [5], and [6], I used weather, W_t , as an instrumental variable (IV) for the export quantity, Q_t , to address the potential simultaneity bias (i.e., the price could be high partially due to

³⁴Although these control variables are not explicitly modeled in the previous section, their inclusion is informed by the existing researches. Structural interpretations of the tea price may not be straightforward because, even though I assume its exogeneity for reasons I discuss shortly, its inclusion may seem to assume that tea and coffee are substitutes. Hence there is a tension between conceptual clarity and the need to incorporate empirically relevant variables.

Structural modeling of the tea market is beyond the scope of this paper, and I believe the tea price is sufficiently exogenous to the developments in the coffee market for three reasons: (1) producing countries are different (e.g., Argentina, China, India, Iran, Japan, Sri Lanka, Turkey, Georgia, and Azerbaijan), and some of them produce exclusively for domestic consumption because tea is more differentiated than coffee; (2) importing countries are different (e.g., the U.K., Russia, Iraq, Saudi Arabia, Syria, and Egypt); and (3) the U.S. imports only about 5% of global production, and over 80% of tea is consumed as iced tea in America, hence there is limited scope for substitution with coffee, which is more often served hot.

³⁵The error term ε_t is allowed to be serially correlated in my estimation of the standard errors.

some positive demand shocks) and measurement error (i.e., export quantities are recorded only annually). The results look reasonable with negative price-quantity relationships and positive coefficients on both the buyers' GDP and the tea price. In what follows, I will use [6] as the baseline result because the use of IV is preferable to OLS in the presence of potential simultaneity bias and measurement error, and because it employs a full set of controls.

Since the quantity coefficient will be the key input for all of the subsequent analyses, it deserves closer attention. First, compared with the OLS estimates, the IV estimates are more stable and pronounced in magnitude, which is an intuitive result because we would expect the weather IV to cut both the demand-side shocks and the noises due to measurement error. Second, although the inclusion of the tea price reflects a compromise between conceptual cleanliness and practicality, it is reassuring to find similar quantity coefficients in columns [5] and [6], i.e., with and without the tea price. Third, the quantity coefficient in column [6] (preferred specification) implies the price elasticity of 0.15 at the mean price and quantity. The existing researches also reported rather low estimates around 0.2.³⁶ Thus, I see desirable features in these demand estimates, which will in turn facilitate our market-power interpretation of observed markups (Section 5.2) and enable us to assess the welfare impact of the cartel treaty (Section 6).

The subsequent analyses will focus exclusively on the supply-side explanations of the price decline, but a plausible alternative hypothesis would come from the demand side as well. In Appendix, I will discuss the other possible explanations and report additional demand estimation results.

5.2 Estimates for the Cartel's Coordination

I measured the extent of cooperation among the cartel countries by observing the markup and the net demand curve the countries face. To facilitate the interpretation of the measure, one can normalize the price-cost margin by the price coefficients of the demand estimate. From equation (7) we have

$$\left(\frac{\partial P}{\partial Q}\right)^{-1} = \alpha_1.$$

Combine this equation with equation (5) to obtain the empirical counterpart to the collusion parameter:

$$\hat{\mu}_t \equiv (P_t - \overline{mc}_t) \frac{-\hat{\alpha}_1}{Q_t^C} \in (0, 1), \quad (8)$$

which reflects the extent of cooperation. This parameter μ_t takes values between zero and one, and equals $1/N$, where N is the *effective* number of (symmetric Cournot) competitors.

³⁶See Bates (1997, Appendix) for a summary of the previous estimates.

Before proceeding to the estimation results, three technical remarks are in order. First, the industry aggregate equation (8) assumes all countries have the same μ_i , which is consistent with the institutional setup where a single administrative body (ICO) operated the international cartel, and suitable for our aim of measuring its effective market power.³⁷ Second, this common- μ assumption implies that differences in countries' outputs are a function solely of differences in marginal costs, as Reiss and Wolak (2007) pointed out. Our dataset contains suggestive evidence supporting this implication.³⁸ Third, our estimate, $\hat{\mu}_t$, is robust to any actual functioning of the cartel and its individual members' behavior (including dynamic game-theoretic interactions) because the identification of $\hat{\mu}_t$ in this paper uses data on \overline{mc}_t rather than its estimates. With these background considerations in mind, let us now examine the estimates.

(Figure 6 here)

Figure 6 contains three key messages about the evolution of market power in the coffee bean market. First, the post-cartel average of $\hat{\mu}_t$, $\hat{\mu}_{post}$, is 0.0163, which is equivalent to a 61-firm Cournot competition. The t -test rejects $\hat{\mu}_{post} = 0$ (i.e., perfect competition $\hat{N}_{post} = \infty$), which is surprising given how close $\hat{\mu}_{post}$ is to zero. More importantly, the t -test does *not* reject $\hat{\mu}_{post} = 0.0182 = 1/55$ (hence $\hat{N}_{post} = 55$, the actual number of competing countries), which is also surprising because $\hat{\mu}_t$ is allowed to take continuous values and therefore not constrained to take values consistent with a 55-firm Cournot model. Thus, the market power estimate for the period after July 1989 seems compatible with oligopoly.

Second, the cartel period average, $\hat{\mu}_{cartel}$, is 0.1016, implying a 10-firm Cournot competition. This level of coordination is far from the extreme theoretical possibility of monopoly pricing ($\mu = N = 1$), and any level of N over 4 or 5 is often considered quite competitive (e.g., Bresnahan and Reiss 1991). Still, given that 55 countries actually compete in the market, this level of market power is economically significant.

Third, the mean difference between $\hat{\mu}_{post}$ and $\hat{\mu}_{cartel}$ is statistically significant at the 1-percent level, suggesting that the cartel exercised measurable market power. This gap reflects the breakdown of the ICA, under the assumption of constant μ_t during and after the ICA, respectively.³⁹ Now that we measured and interpreted the extent of market power under the ICA, the remaining task is to assess its economic impact in terms of price and social welfare.

³⁷Besides, "there is very little economic theory to guide structural models of how $[\mu_i]$ varies across firms" (Reiss and Wolak 2007, p. 4330).

³⁸I found a negative correlation ($-.26$) between the country rankings in q_i and mc_i (1979–88 average). We should expect this inverse relationship if we assume marginal costs are increasing in output. Alternatively, we can also assume constant marginal costs up to capacity, which becomes binding only under severe weather shocks, as the experience of countries such as Brazil suggests.

³⁹The 1989 lapse of the ICA roughly coincides with the abolition of national coffee boards in some exporting countries. In Brazil, for example, then-President Collor dismantled the coffee ministry in 1992, which reduced

6 Welfare Analysis of the Coffee Cartel

In this section, we seek to understand the economic impacts of ICA, the cartel treaty.

6.1 Wealth Transfer under the ICA (1979–1988)

Based on the estimated demand and the post-cartel market power, we can calculate the pre-July 1989 counterfactual prices and quantities that would have prevailed had the cartel agreement never materialized (i.e., if the U.S. had not participated in the ICA). Table 4 compares the actual (column [A]) and counterfactual (column [B]) prices, exports, consumer surplus, producer surplus, and social welfare, and displays their differences (column [C]). This simulation will provide us with the benchmark economic outcomes against which to measure the welfare impact of the cartel treaty.

(Table 4 here)

Without ICA, the coffee price would have been lower by 132 cents at 182.1 cents, which is reassuringly consistent with the reduced-form estimates (between 138 and 162 cents), and the world exports higher by 5.3 million bags at 50.6 million bags. As a result of the ICA, the world's consumers gave up \$8.4 billion every year, most of which was transferred to the producing countries (\$7.7 billion).

To put these numbers in context, we can compare them with the amount of foreign aid. Specifically, the annual Official Development Assistance (ODA) averaged at \$64.9 billion (in 2007 constant U.S. dollars, for the comparable period 1979–88), of which \$14.8 billion came from the U.S., followed by Japan (\$9.3 billion), France (\$7.8 billion), Germany (\$7.3 billion), and the U.K. (\$4.1 billion). Hence the effective wealth transfer of \$8.4 billion under the ICA mechanism amounted to as much as 13% of the world's total ODA, more than half of American ODA, or about as much as what countries such as Japan, France, and Germany each spent for aid. Although treaties like ICA are not officially counted as foreign aid, our estimates suggest they might have sizeable impacts in developing countries, nearly half of which export coffee beans.

the extent of domestic coordination among regions and farms. This development could have led farms to compete more aggressively than before, eventually slashing what market power was left internationally in the years since 1989. Rather than a separate event that changed the market structure, I viewed this development as a part of the cartel breakdown episode. Once the international quota is gone, coordinating supply domestically makes little sense. Even if farms in one country manage to suppress output collectively, thousands of foreign farms are always ready to fill the gap. Thus I interpreted my measure of market power (drop thereof in 1989) as a reflection of the demise of ICA, which logically entailed the disappearance of supply coordination at the sub-national level through national coffee boards.

6.2 Decomposing the Coffee Crisis (1989–2001)

While the preceding welfare analysis focused on the cartel period using the no-cartel counterfactual, we can also simulate the post-cartel evolution of coffee price under hypothetical market structures (with/without the ICA and with/without Vietnam’s exports). The goal is to quantify the likely price-impacts of the cartel’s breakdown and the emergence of Vietnam circa 2001, i.e., decomposition of the “coffee crisis.” The simulation results are displayed in Figure 7.

(Figure 7 here)

Figure 7 shows that both the cartel’s breakdown and the increased exports from Vietnam had visible effects on the coffee bean price. Let us carefully examine each factor. First, the actual price in 1988 and 2001 were 211.9 and 64.2 cents (annual average), respectively, hence a 69.7% drop. Second, the counterfactual 2001 price would have been 201.7 cents, at a level 137.5 cents higher than the actual price, had the ICA continued to function (*Scenario 2* in Figure 7). Third, if we further hypothesize that Vietnam had never expanded its coffee sector (*Scenario 1* in Figure 7), the 2001 price would have been 229.0 cents, representing an additional increase of 27.3 cents. This result suggests that the coffee price in 2001 could have stayed near the 1988 level if the market structure had not changed so drastically. Of course, our model does not incorporate every possible factors influencing price, so some discrepancies exist between its prediction and the actual prices. But the overall picture is clear: the lapse of the ICA explains at least four-fifths of the price decline during the 1990s, with Vietnam contributing some additional fraction.

Let us also note that these quantification results based on our structural modeling and estimation broadly agree with the reduced-form estimates in Section 3.2. The results from these two approaches are comparable in this study because both rely on the same sources of exogenous variation in market structure (i.e., the U.S. foreign policy toward the commodity trade and the government-led coffee development in Vietnam). Hence the close match of the structural estimates with the reduced-form results makes us comfortable in believing that the welfare analysis in Section 6.1 would probably represents realistic economic gains and losses, and that the simulations in this section offer a reasonable decomposition to explain the “coffee crisis.” The additional leverage we earned from the structural estimation was the intuitive measurement of market power under the cartel treaty and the policy evaluation based on welfare analysis.

7 Conclusion

This paper aims to advance the analysis of international commodity markets based on economic fundamentals. Two findings emerge. First, the International Coffee Agreement (ICA) raised price by 73 percent, annually transferring approximately 8 billion dollars from consumers to exporting countries. Second, the lapse of ICA in 1989 explains four-fifths of the subsequent price decline, i.e., the coffee crisis. These estimates indicate that the ICA's market power and its welfare impacts were substantial.

From the public-policy perspective, these results are informing us that market power could be generated by a trade agreement and used as a device for foreign aid, which was the intention of the U.S. foreign policy during the Cold War era. Likewise, the coffee price declined when the United States reversed this trade/aid policy and withdrew its support for the ICA regime in 1989. Although the falling bean price benefited coffee drinkers across the globe and was certainly an *intended* consequence from the perspective of the U.S. trade-policy makers, the potential magnitude of spillover effects (e.g., the exporting countries' sovereign debt cancellations and the intensifying violence in some areas) suggests that a more gradual withdrawal might have reduced the total cost of handling all such contingencies abroad. Another alternative would be not to engage in the creation of market power in the first place because it certainly hurt consumers in the developed world and the eventual reversal of such a policy entailed a severe commodity crisis, with large adjustment costs in the developing countries as well.

From the positivistic viewpoint, these results also reveal that, contrary to the conventional perception of commodity markets as purely speculative and highly unpredictable, economic fundamentals of demand and supply are useful for their analysis. Most importantly, despite the textbook-characterization of these markets as perfectly competitive, economic forces of oligopoly are fully at play. In addition to the coffee market, the markets for crude oil, diamonds, base metals, and tropical agricultural, to name but a few, also have a reputation for cartels and imperfect competition. Each commodity has particular characteristics and its market may feature unique institutional background, so analysts need to be careful about the generalizability of this paper's findings. Each market requires careful analysis of its own. But the results of this research would allow us to make an educated guess, at least, about the likely extent of market power in those markets that have historically operated under either cartel or commodity trade agreements similar to the ICA (e.g., cocoa, rubber, sugar, and tin). Economic analysis of internationally traded commodities would gain much from explicitly incorporating market structure.

Appendix: Alternative Explanations of the Coffee Crisis from the Demand Side

I have considered an alternative hypothesis to explain the steep decline of coffee prices during the 1990s. In this Appendix, I discuss a possibility that changes on the demand side might have caused the markup to shrink, thereby suggesting an alternative mechanism for the coffee crisis. Specifically, an increase in the price elasticity of demand would lower the equilibrium price independently of changes in market structure (i.e., supply side). After estimating the coffee bean demand for different periods (Table A-1), however, I found no evidence that consumers became more price-sensitive during the 1990s. The estimates suggest an opposite tendency, if any. When I split the sample by decade (column [1] through [5] of Table A-1), the quantity coefficients for the 1980s, 1990s, and 2000s are -268.5 , -146.3 , and -21.7 , which imply the following price elasticities: 0.17, 0.08, and 0.04, respectively. I also split the sample in two, before and since July 1989 (i.e., the month when the cartel treaty lapsed), but again found suggestive evidence in the opposite direction. Columns [6] and [7] of Table A-1 show that the price-quantity relationship weakened in magnitude from -322.9 to -153.5 , implying the elasticities of 0.26 and 0.16, respectively. These considerations lead me to conclude that the demand for coffee beans has not become more price-sensitive, so my baseline results are likely to indicate the *lower bound* of the price-impacts that the supply-side factors could have had.⁴⁰

(Table A-1 here)

Why do changes in importing countries fail to make demand more price-sensitive? First, the evolution of consumers' tastes is not uniform or monotonic across the globe. According to America's National Coffee Association, per-capita consumption in the United States peaked in 1962 at 3.12 cups per day and dropped to 1.76 in 2005, but this decline has happened only gradually over five decades.⁴¹ This development is likely more than offset by the population growth during the same period, along with the increasing per-capita consumption in other populous countries such as Japan and Germany, as well as the growth of emerging economies.

⁴⁰I did not use the demand estimates in Table A-1 as the main results because, although all of the coefficient estimates are statistically significant, the goodness of fit varies considerably between sub-samples, possibly due to the differing patterns across decades of weather shocks.

⁴¹Trade press suggests several underlying developments behind such long-run changes in demand: (1) the introduction of substitutes such as bottled water and caffeinated energy drinks; (2) the price wars between Coca Cola and Pepsi that since the 1990s have lowered cola prices (arguably a close substitute for coffee); and (3) an increased "health-consciousness" that somehow deterred many consumers from drinking coffee.

Second, corporate buyers of coffee beans have not accumulated monopsony (oligopsony) power to match the monopoly power of exporters.⁴² These buyers are manufacturing firms that process beans into roasted or ground coffee products. Despite occasional mergers and acquisitions, the roasting industry was still comprised of 219 companies in 1992, 215 in 1997, 284 in 2003, and 253 in 2008 (IBISWorld 2008). Explaining the declining bean price by an increase in the roasters' oligopsony power is therefore difficult. Furthermore, since the governments of the importing countries policed the cartel agreement, the companies in those countries were unlikely to have influenced the exporting countries' market power on their own.

Finally, there is Starbucks Coffee, the largest coffee shop chain in the world. Could Starbucks' meteoric rise in the late 1990s and early 2000s somehow increase the price-sensitivity of global coffee demand? Odds are against this explanation given the following facts. Even as late as 2007, Starbucks purchased less than 5 percent of the total global green-bean exports. This number alone would rule out the Starbucks hypothesis.⁴³ In a broader context, coffee shops are a new channel of coffee retailing, but the overall per-capita consumption of coffee in the United States remained roughly constant between the late 1980s and 2000s. In other words, consumers merely switched from supermarkets to coffee shops as a point of purchase, and only partially. Moreover, although new to America, coffee houses have been around for centuries in Europe and Japan. London's coffee houses opened in the seventeenth century—at around the same time modern corporations were invented—and the first coffee shop opened in Japan in 1878. Hence Starbucks Coffee and the emergence of coffee shops in the United States are unlikely to have changed the global pattern of coffee bean demand, at least not in time to explain the decline of coffee prices during the 1990s.

Thus, I believe it is reasonable to focus on the supply-side explanations such as the cartel's collapse and extra coffee shipments from Vietnam.

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⁴²I abstract from the multi-layered buyers. See Nakamura and Zerom (2010) for the analysis of vertical relationships and incomplete pass-through at the wholesale and retail levels in the United States.

⁴³This calculation is based on Starbucks Corporation's Form 10-K for the fiscal year ending September 30, 2007. As of September 30, 2007, the company had \$324 million in fixed-price purchase commitments, \$49 million in price-to-be-fixed contracts, and \$339 million in unroasted bean inventories. Evaluated at the prevailing spot price of \$1.35 per pound, the total amounts to 1.816 million 60-kg bags, which the company deemed enough stock of green coffee through the fiscal year 2008. This represents a mere 4.5% of the world export in 2007 (88.148 million 60-kg bags).

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Table 1: Summary Statistics

Variable	Unit of Measurement	Num. Obs.	Mean	Std. Dev.	Min	Max
Price (P_t)	US cents	576	242	148	44	1131
Cost (mc_t)	US cents	360	127	60	41	283
Markup ($m_t \equiv \frac{P_t - mc_t}{P_t}$)	–	360	0.29	0.32	–0.97	0.75
World Export (Q_t)	Million 60kg bags	576	5.472	1.173	3.473	7.859
of which Cartel (Q_t^C)	Million 60kg bags	576	5.187	0.840	3.470	6.592
of which Vietnam (q_t^V)	Million 60kg bags	576	0.285	0.456	0.002	1.558
Cartel Breakdown (I_t)	0/1 indicator	576	.39	.49	0	1
Weather Shocks (W_t)	Set of 0/1 indicators	576	–	–	0	1
Buyers' GDP (X_t)	Log of trillion US dollars	576	0.19	0.44	–0.71	0.84
Tea Price (Z_t)	US cents	576	484	246	189	1435

Note: Prices and GDP are expressed in the 2007 constant U.S. dollars. All variables are recorded at the monthly frequency between January 1960 and December 2006 except for Cost, Export quantities, and GDP, which are recorded annually and converted to monthly figures. Cost data (hence markup, too) are available only for 30 years.

Source: Commodity Research Bureau (CRB) for the prices of coffee and tea, United States Department of Agriculture (USDA) for the export quantities, International Coffee Organization (ICO) for the farm-gate prices (measures of Cost), and International Monetary Fund (IMF) for the importing countries' GDP. The Markup, Cartel Breakdown, and Weather Shocks are constructed by the author.

Table 2: Reduced-form Analysis of Coffee Price Determination

Dep. var.: P_t (Coffee Price)	OLS					
	[1]	[2]	[3]	[4]	[5]	[6]
I_t (Cartel Breakdown)	-194.4*** (9.7)		-163.7*** (14.8)	-138.1*** (8.2)	-161.6*** (9.6)	-156.9*** (8.4)
q_t^V (Vietnam's Export)		-175.9*** (11.4)	-43.3*** (15.9)	-29.4*** (8.4)	-41.7*** (8.6)	-69.8*** (7.9)
X_t (Buyers' GDP)					42.93*** (9.58)	218.85*** (16.25)
Z_t (Tea price)						.3229*** (.0256)
Constant	317.2*** (6.0)	292.3*** (6.1)	317.6*** (6.0)	257.8*** (4.0)	264.2*** (4.2)	80.5*** (15.0)
W_t (Weather Shocks)	No	No	No	Yes	Yes	Yes
Adjusted R^2	.41	.29	.42	.85	.86	.89
Number of observations	576	576	576	576	576	576

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Standard errors are in parentheses.

Table 3: Estimates of World Coffee Bean Demand

Dep. var.: P_t (Coffee Price)	OLS			IV		
	[1]	[2]	[3]	[4]	[5]	[6]
Q_t (Coffee Exports)	-75.6*** (4.2)	-200.6*** (10.5)	-194.4*** (8.6)	-284.0*** (1.5)	-326.9*** (4.4)	-295.5*** (4.4)
X_t (Buyers' GDP)		357.2*** (28.2)	616.6*** (27.5)		684.0*** (12.5)	870.9*** (14.3)
Z_t (Tea Price)			.5484*** (.0321)			.5326*** (.0074)
Constant	656*** (24)	1271*** (53)	922*** (48)	1796*** (9)	1897*** (20)	-1432*** (19)
Adjusted R^2	.36	.50	.67	-	.37	.59
Number of observations	576	576	576	576	576	576

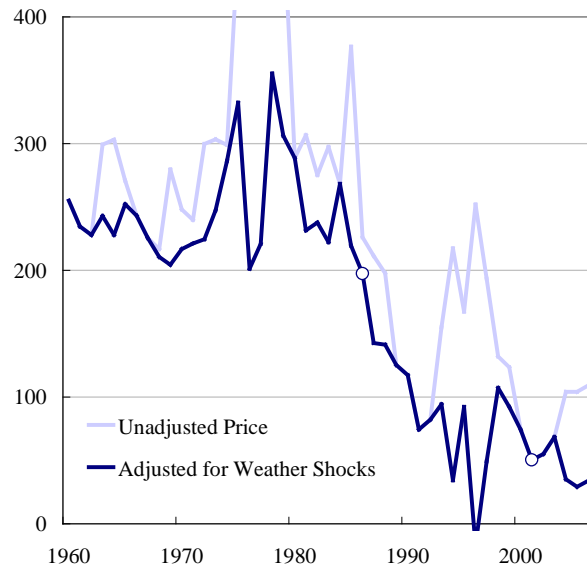
Note: The IV estimation uses weather shocks as the instruments for Coffee Exports. Column [4] does not report R-squared because it is negative. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Heteroskedasticity- and autocorrelation-consistent standard errors are in parentheses.

Table 4: Welfare Analysis of the International Coffee Agreement

Annualized 1979–88 average	[A] Actual (with Cartel)	[B] Counterfactual (without Cartel)	[C] Difference ([A] – [B])
(1) Price (cents/lb)	314.5	182.1	132.4
(2) World Exports (million bags)	45.3	50.6	-5.3
(3) Consumer Surplus (million \$)	33,422	41,819	-8,397
(4) Producer Surplus (million \$)	9,586	1,855	7,731
(5) Social Welfare = (3) + (4)	43,008	43,674	-666

Note: Prices and surpluses are expressed in the 2007 constant U.S. dollars.

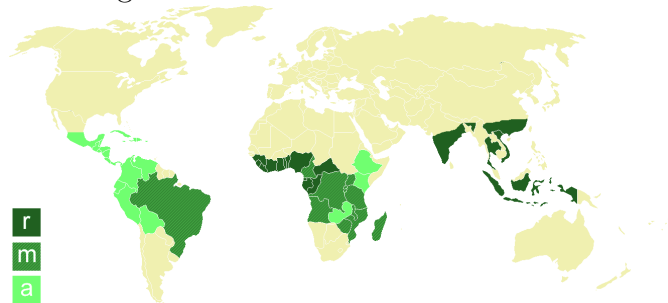
Figure 1: Real Price of Coffee Beans
(cents/lb)



Note: The prices are in the 2007 constant US dollar. The Adjusted price plots the residual from regressing the original Unadjusted price on the weather shock variable, which is explained in Section 3.

Source: Commodity Research Bureau (CRB), Bureau of Labor Statistics (BLS), United States Department of Agriculture (USDA), and Author's calculations.

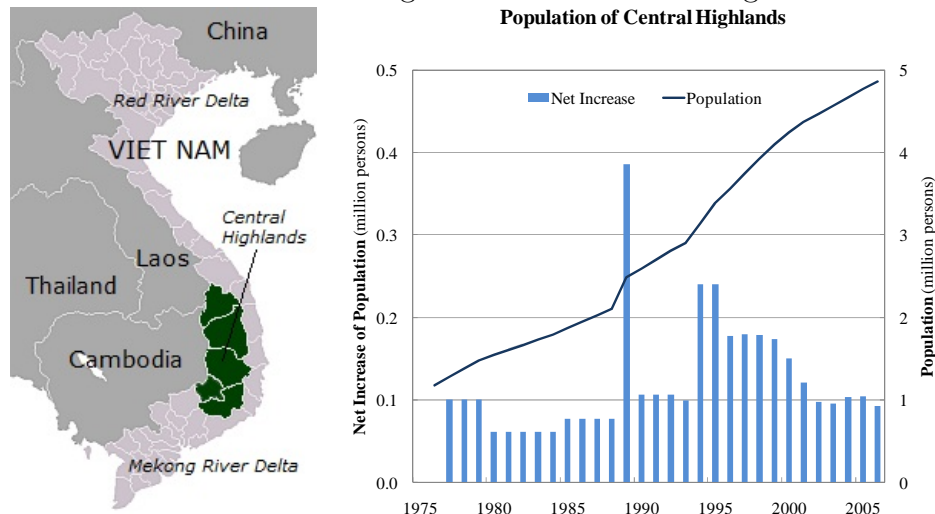
Figure 2: Areas of Coffee Cultivation



Note: r, m, or a indicates cultivation areas for robusta, mixture of robusta and arabica, or arabica species.

Source: Wikipedia.

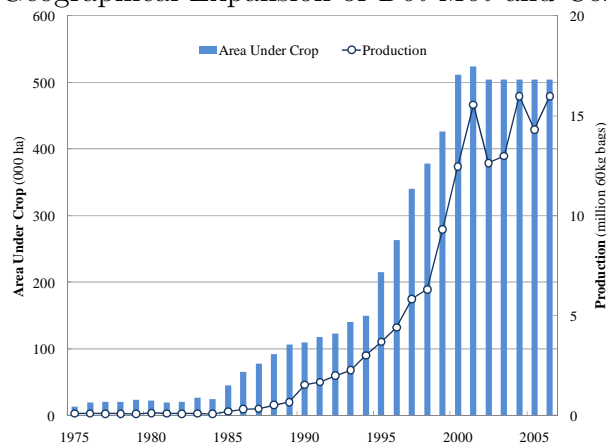
Figure 3: The Government-led Migration to the Central Highlands of Vietnam



Note: The Central Highlands' key attributes are apparent in the map - (1) landlocked, (2) far from the densely populated Delta regions, and (3) bordering Laos and Cambodia. The region also belongs to the southern half of the territory, implying the ease of access to its ethnic minorities from the American side during the war.

Source: The map is made by the author from Wikipedia's material. The population data since 1995 are from the General Statistics Office of Vietnam, and the rest is from Jan Lahmeyer's populstat site (retrieved on July 7, 2011, from <http://www.populstat.info/Asia/vietnamp.htm>).

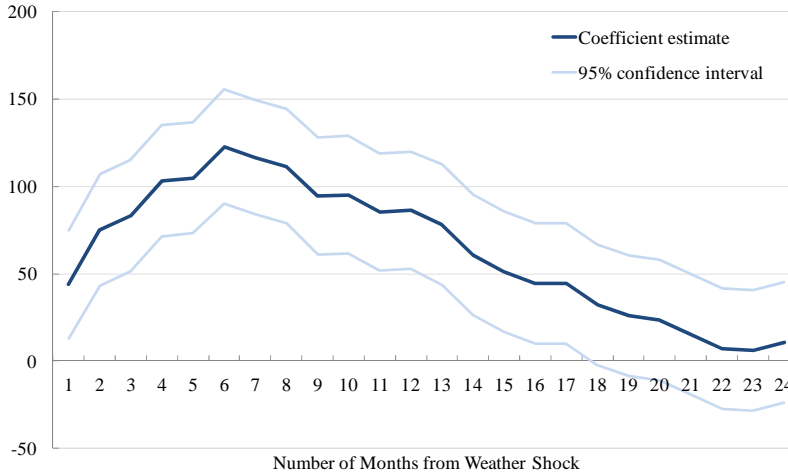
Figure 4: The Geographical Expansion of *Doi Moi* and Coffee Production



Source: Reconciled between VICOFA, Reuters, USDA, and GSO, by Asia Commodities JSC. Retrieved on July 7, 2011, from the website of the Vietnamese Initiative for Food and Agricultural Policy at <http://www.vifap.org/archives/89>.

Figure 5: Effects of Brazilian Frosts on Coffee Bean Price

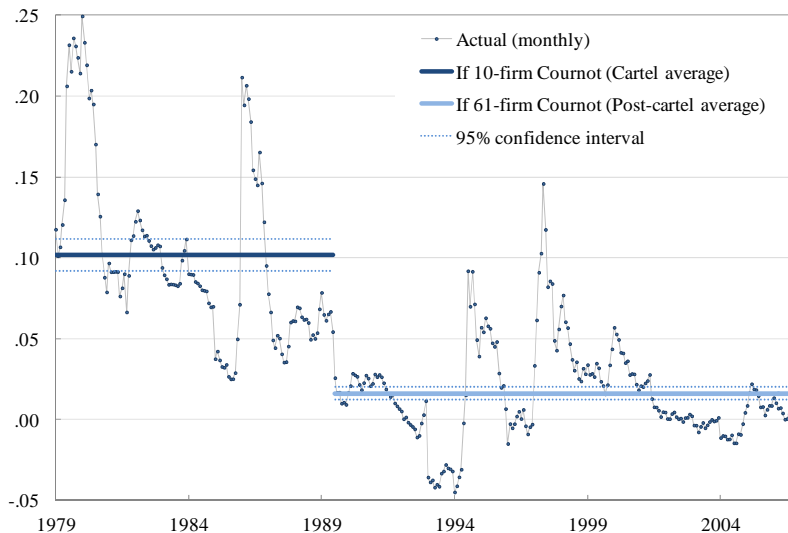
Impact on Coffee Price
(cents/lb)



Note: Estimates are based on the regression in Column [6] of Table 2.

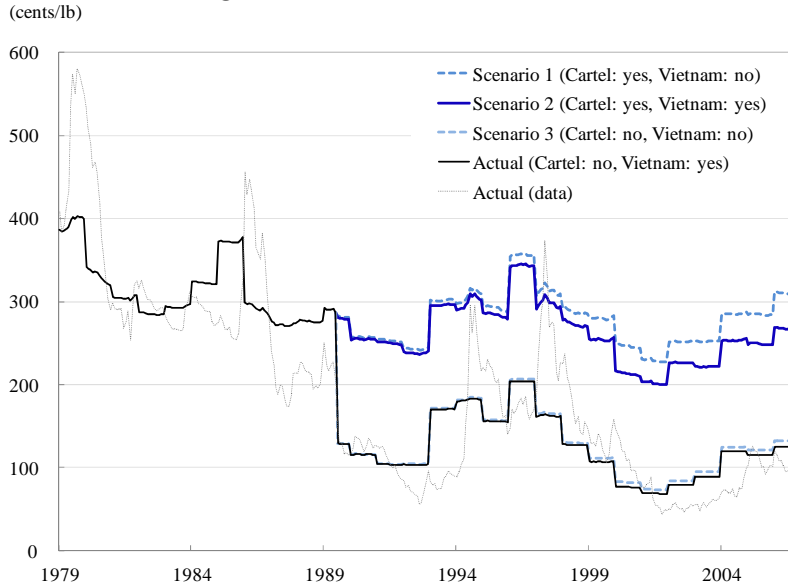
Figure 6: The Estimated Degree of Coordination among The ICA Exporters ($\hat{\mu}_t$)

(= 1 if Perfect Collusion,
= 0 if Perfect Competition)



Note: The collusion parameter (μ_t) among coffee exporters excluding Vietnam. Calculation is based on price and cost data, together with demand estimates (column [6] of Table 3). The number equals 1 under perfect collusion, 0 under perfect competition, and $1/N$ under N -firm symmetric Cournot competition.

Figure 7: Counterfactual Prices



Note: *Scenario 1* is the most profitable case for the coffee exporters based on (1) the traditional exporters' maintaining the degree of collusiveness at 0.10 (1979-88 average) even after July 1989, and (2) zero exports leaving Vietnam in all years. *Scenario 2* assumes only (1). *Scenario 3* assumes only (2). The *Actual* case witnessed both the cartel breakdown and Vietnam's export expansion.

Table A-1: Demand Estimates by Decade and Before/After July 1989

Dep. var.: P_t (Coffee Price)	By Decade					Before/After July 1989	
	1960s	1970s	1980s	1990s	2000s	Before	After
Q_t (Coffee Exports)	-111.1*** (5.5)	-233.0*** (9.8)	-268.5*** (60.0)	-146.3*** (60.0)	-21.7*** (4.8)	-322.9*** (13.6)	-153.5*** (7.1)
X_t (Buyers' GDP)	209.3*** (19.9)	1170.4*** (37.2)	858.8*** (318.5)	1044.1*** (71.3)	466.2*** (27.2)	909.1*** (19.5)	617.5*** (71.5)
Z_t (Tea Price)	.0461*** (.0156)	.5277*** (.0094)	.2638*** (.0645)	.3481*** (.0062)	.5653*** (.0197)	.4332*** (.0229)	.6784*** (.0329)
Constant	765*** (23)	1195*** (46)	1431*** (246)	404*** (8)	-244*** (17)	1642*** (69)	582*** (15)
Adjusted R^2	.48	.83	.07	.31	.66	.60	.11
Number of observations	120	120	120	120	96	354	222

Note: All estimates use weather shocks as the instruments for Coffee Exports, hence the specification is the same as in column [6] of Table 3. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Heteroskedasticity- and autocorrelation-consistent standard errors are in parentheses.