The Transition to Modern Agriculture: Contract Farming in Developing Economies

Abstract

Recent years have seen considerable interest in the impact of contract farming on farmers in developing countries, motivated out of belief that contract farming spurs the transition to modern agriculture. In this paper, we provide a thorough review of the empirical literature on contract farming in both developed and developing countries, paying careful attention to broad implications of this research for economic development. We first find empirical studies consistently support the positive contribution of contract farming to production and supply chain efficiency. We also find that most empirical studies identify a positive and significant effect of contract farming on farmer welfare, yet are often unable to reach consistent conclusions as to significant correlates of contract participation. We support our review with a meta-analysis of the empirical literature to identify study characteristics that are conditionally correlated with particular empirical outcomes. Our meta-analysis indicates that studies using larger, more recent datasets are more likely to report a priori expected empirical results, but that empirical findings are not statistically different across developmental status or agricultural commodities.

Contract farming (CF) has long been established in developed countries. In recent decades, it has become more popular in developing countries, yet the fundamentals of CF are different across developed and developing countries primarily because the latter is inescapably linked to economic development. These differences raise important issues for governments, especially those in developing countries, as to whether they should adopt a policy to promote, regulate, or prevent the development of CF, or to leave the status quo. In this article, we review and synthesize the existing research on CF, comparing studies related to developed and developing countries, in order to identify general conclusions developed by the literature. We focus on CF as a vehicle of transition to modern agriculture in developing economies, using China as an example.

Driven by competition in the food market, the food supply chain has quickly become vertically coordinated in developed countries, with CF as the dominant form of coordination for most traditional commodities. It is generally agreed that two major reasons explain why farmers opt to contract with a downstream processor and marketer: risk reduction (Allen and Lueck 1995; Hennessey and Lawrence 1999) and transaction cost reduction (Hobbs and Young 1999).

For developing countries, there are other potential benefits associated with CF. Since farm scale tends to be small, farmers are generally less educated, production and management technologies are less efficient, and infrastructure such as transportation, cold storage, and information channels are underdeveloped; contracting with a large agribusiness firm may be the only way farmers in developing countries can access higher end markets and receive higher returns (Barrett et al. 2012). Transaction cost reduction is

also an important motive given relative scarcity of resources (Bijman 2008). These two motives may be more important than the risk reducing motive (Wang et al. 2011).

The consequences and impacts from food supply chain coordination may also be different in developed versus developing economies. In both economies, CF provides a stable and consistent supply to the downstream food processors and consumers, gives the processors more control, makes food traceable, and reduces transaction costs. In developed countries, farmers are concerned about losing their independence and important business decision skills (Schulze et al. 2006); yet, in developing countries, farmers may acquire better production technology, achieve scale economies, and receive a higher return to improve their welfare (Tripathi et al. 2005; Miyata et al. 2009). Indeed, CF may help modernize the entire agricultural sector (Morrissy 1974), which is one important aspect of economic development. However, there are also concerns associated with CF, particularly salient for developing countries, including increased instability for nonparticipants in the community; disruption of power relations in traditional household culture; overreliance on cash crops that may leave households more vulnerable to food shortages; and exploitation from large firms (Key and Runsten 1999).

To anchor our discussion of CF in developing countries, we focus on China as a particular case. While there may be considerable heterogeneity across developing countries with respect to CF, studies focusing on China may yield important implications on CF in developing countries for the following reasons. First, China has a large number of small and low income farms. Second, different from other developing countries in Latin America or Africa that were open to foreign firms in the 1970s, China is a late

comer without a long tradition of contracting, providing an opportunity to understand how the introduction of CF impacts development. Third, China has a large domestic food market and newly established domestic firms to serve this market (many processors are domestic firms). Fourth, China has a strong government with regulatory as well as promotional powers.

In this paper, we make two contributions to the empirical literature on CF. We first provide a thorough review of the existing empirical literature, focusing on factors that motivate farmer participation in CF and the impact of CF on agricultural productivity and farmer welfare in developing countries (section 3). Second, we conduct a meta-analysis of the existing empirical literature to look for attributes that may explain why the empirical literature has failed to identify consistent effects of several variables on the decision to contract and its impact (section 4).

A Brief Conceptual Overview

We first provide a basic conceptual definition and a cursory description of several important theoretical developments in the literature. Readers are referred to the references provided in this section for further theoretical details.

Different to traditional marketing in which farmers produce under their own decisions on variety, quantity, quality, and timing, and then sell to the open market at the market price at harvest[1], CF refers to "agricultural production carried out according to an agreement between a buyer and farmers, which establishes conditions for the production and marketing of a farm product or products" (FAO 2013). Typically, the farmer agrees

to provide certain quantities of a specific commodity at the specified quality standards and time, while the buyer commits to pay at a specified price or pricing scheme. The buyer may also supply some inputs or technical support to the farmer.

Reasons supporting vertical coordination in the food supply chain through CF are similar to vertical integration, except the buyer does not have to assume the full responsibility of financial investment and risks, rather sharing these with farmers (Schrader 1986). Economic contracting theories have long been established in general (Coase 1937), for vertical integration (Williamson 1971), and for marketing contracts around risk and information (Laffont and Tirole 1986; Allen and Lueck 1995). The application of such theory in agriculture can be traced back to the 1990s (Hennessy 1996; Leathers 1999; Goodhue 2000). For a discussion and review, see Wu (2006).

CF has quickly spilled over from developed countries to developing countries, especially since large agribusiness firms began to acquire fresh produce from Latin America to supply their home markets. CF helps the modernization of small growers (Morrissy, 1974), and also has economic, political, and social impacts (Glover 1984).

The Empirics of Contract Farming

There is a rich empirical literature investigating two primary facets of CF: participation incentives and the impact on farms. The econometrics for the former is often a simple binary outcome modeled with probit or logit regression. The latter, itself, has many facets, including the effects of CF on farm growth, productivity, income, or product quality, often evaluated by including a binary explanatory variable of CF participation.

Contract Participation

Many estimate the probability that a farmer will choose to contract as the first step in a two-step econometric procedure focusing primarily on the impact of CF on farmer welfare (e.g., Katchova and Miranda 2004; Simmons et al. 2005; Miyata et al. 2009; Wang et al. 2011; Bellemare 2012; Ito et al. 2012). Others focus exclusively on farmers' decision to contract (e.g., Guo 2005; Masakure and Henson 2005; Zhu and Wang 2007). Under the presumption that CF improves welfare – a consensus reached theoretically and empirically – it is vital to fully understand which factors are associated with farmers' willingness to contract, in order to leverage welfare gains and economic development.

Demographic Factors

Age, gender, and education are often included in empirical studies. Unfortunately, there fails to be a consensus as to both the sign and significance of each of these demographic variables on the probability of participation. Many find that the age of the head of the household has a significantly negative effect, such as Simmons et al. (2005) for seed corn in Indonesia and Bellemare (2012) for several commodities in Madagascar. However, Katchova and Miranda (2004) find that age has a significantly positive effect for soybean in the United States. Simmons et al. (2005) find an insignificant effect for seed rice and broilers in Indonesia, so do Katchova and Miranda (2004) for corn and wheat in the U.S. Ito et al. (2012) find a nonlinear age effect for watermelon in China.

For gender, Wang et al. (2011), Bellemare (2012) and Wainaina et al. (2012) document that females are significantly less likely to adopt CF than males in China, Madagascar and Kenya, respectively. One possible explanation is that, in developing

countries, institutional forces may provide females with disadvantageous contract opportunities or conditions. Conversely, Leung et al. (2008), Arumugam et al. (2011), Hu (2012), Freguin-Gresh et al. (2012), and Wang et al. (2013) all document an insignificant gender effect across both developed and developing countries and for a variety of commodities. There is no apparent explanation for the differing conclusions.

A large number of studies have found that the education level of the head of the household is not significantly related to participation in a contract (Guo et al. 2005; Wang et al. 2011; Bellemare 2012; Ito et al. 2012; Wang et al. 2013). Yet, there are other studies that find it significantly positive (Zhu and Wang 2007; Arumugam et al. 2011; Hu 2012), negative (Ramaswami et al. 2006; Miyata et al. 2009; Wainaina et al. 2012), or dependent on commodity (Simmons et al. 2005; Katchova and Miranda 2004). One possible explanation for these differing conclusions is that the education effect is nonlinear (Miyata et al. 2009).

While one might anticipate differences in the relationship between these basic demographics and contract participation across developed and developing countries, the widespread failure to obtain a general conclusion is perplexing. One possibility is that these differences arise because of statistical or modeling differences – a dimension that we explore in our subsequent meta-study of contract participation findings. Another possibility is that institutional differences across countries and across commodities within countries may lead to heterogeneity. It suggests policymakers who seek to promote CF as a means of increasing farmer welfare should use caution when designing policies targeting farmer participation, and be wary of the implications of heterogeneity.

Economic Factors

Farm size, farmer experience, specialization, risk preference, and credit constraints are also investigated. Farm size is measured by either the number of laborers or land acreage. The effect of land acreage is found significantly positive in a large number of studies like Zhu and Wang (2007), Lu and Ma (2010), Arumugam et al. (2011), Wang et al. (2011), Bellemare (2012), Freguin-Gresh (2012), Hu (2012) and Wang et al (2013); negative in Leung et al. (2009); and insignificant in Ito et al. (2012), Birthal et al. (2005), Miyata et al. (2009) and Wainaina et al. (2012). Simmons et al. (2005) find different signs for different commodities. The dominant result that larger farms are more likely to contract is consistent with the common belief that they are more likely to be offered a contract, for the transaction cost saving benefit of the processor. However, it is likely that small farmers may gain more from contracting, and encouraging small farmers to contract is important from a developmental perspective. The number of laborers is generally insignificant (Simmons et al. 2005; Zhu and Wang 2007; Miyata et al. 2009; Wang et al. 2011; Bellemare 2012; Hu 2012; Ito et al. 2012). This is either because it does not affect the participation decision, or its effect can be represented by land acreage.

The effect of farm experience, measured by the number of years farming, is again found divided. Bellemare (2012) finds a positive and significant effect, indicating that more experienced farmers are more likely to contract. Yet, Zhu and Wang (2007) find a negative effect, and Arumugam et al. (2011) fail to uncover a significant link. Two potential explanations for these conflicting findings include the evidence of a nonlinear relationship between experience and contracting (Ramaswami et al. 2006) – more

experienced farmers are less likely to contract, but at a diminishing rate; and the commodity specific effect (Birthal et al. 2005) – experience increases the likelihood of contracting for dairy and vegetable growers, but decreases for broiler farmers.

The effect of farmer specialization, measured as the share of income from their primary crop to that from other farm and non-farm activities, on CF is also diverse, with general findings being divided across significantly positive and insignificant effects. Warning and Key (2002), Guo et al. (2005) and Freguin-Gresh et al. (2012) all document a positive and significant effect, Zhu and Wang (2007), Arumugam et al. (2011) and Hu (2012) find an insignificant effect, while Ramaswami et al. (2006) and Wainaina et al. (2012) find a negative and significant effect. These effects, as indicated by both Katchova and Miranda (2004) and Birthal et al. (2006), are commodity specific.

Simmons et al. (2005) consider farmer access to credit as one potential motive for contract participation. They find that credit constraints are not significant in the corn and rice industry, but positive for broiler growers. This significant effect (for broilers) is intuitive because farmers with poor access to credit may be particularly vulnerable to market fluctuations, and may find increased safety in a contract.[2]

The impact of farmer risk aversion and the degree of market risk on contract participation has been studied by several researchers. Guo et al. (2005), Zhu and Wang (2007) and Ito et al. (2012) all find that farmer risk aversion is not a significant predictor of contract participation. Wang et al. (2011) find that risk aversion is negatively related to contract participation, and Wainaina et al. (2012) find it positive. The Wang et al. (2011) result seems counter-intuitive, yet as they point out, CF is relatively new in China which

makes risk averse farmers wary of contracting. Furthermore, both Guo et al. (2005) and Wang et al. (2011) include measures of price volatility in their studies and find no statistically significant effect on contracting. One interpretation of this literature is that market risk may not be an important driving factor leading farmers to contract in China, or that price risk in an economy where food price keeps rising is favorable to farmers without being locked in a fixed price contract. Taken jointly, these results suggest two interesting insights. First, the majority of authors seem to find no link between contract participation and farmer risk aversion, consistent with the view that CF, at least in developing countries, is less related to risk reductions than market access and cost reductions. Second, policymakers in developing countries should be aware that the introduction of CI may appear risky to farmers who are unaccustomed to contracting. If policymakers wish to use contracting as a policy lever for improving farmer welfare, minimizing initial fears of new ventures into contracting may be crucial.

Many empirical studies have also considered the impact of a farm's assets on the likelihood of participation, measured as either the value of household assets or the value of farm equipment. The majority find that this variable is statistically insignificantly related to contract participation (Simmons et al. 2005; Leung et al. 2008; Wang et al. 2011; Bellemare 2012; Hu 2012; Wainaina et al. 2012). Only Warning and Key (2002) identify a significantly positive effect of the farm equipment assets on contracting for a sample of Senegalese peanut farmers, indicating that farmers with more equipment may have higher productivity and are more capable to repay the initial loan in the contract. One possible explanation for the general insignificance of farm assets in the participation

regression is that farm assets may be an alternative measure of farm size, in which case any size effect may have already been captured by the size of the land.

Several other authors have explored a few interesting participation motives in contracting. Zhu and Wang (2007) find previous experience with CF contributes positively, which suggests that farmers' previous CF experience was likely successful. Although it is obvious that previous positive or negative experience will strongly influence the future decision, given that many studies find evidence that CF increases farmer welfare, the Zhu and Wang's (2007) result indicates that future contracts may be adopted more readily. This result is also consistent with Wang et al. (2011) in that risk averse farmers are less likely to contract given uncertainties of entering into a contract without much precedent. Government promotion policy is another factor that contributes to CF participation in China (Guo 2005; Zhu and Wang 2007), indicating that recent government efforts to encourage CF have been successful. If China is representative of developing countries, these two studies provide crucial evidence that government can play an important role in promoting CF in developing countries.

The distance to market may be a particularly important factor for farmers in developing countries, but is found negative in Kenya (Wainaina et al. 2012) and positive in Lao (Leung et al. 2008). Both results are potentially intuitive. On the one hand, farmers that do not have access to a main road are less attractive partners for the processor, while on the other hand, farmers who are farther from the market may find additional security in contracting given their relative remoteness, and may be more likely to contract. Hence, CF effects may also be dependent on infrastructural development.

Discussion

Despite the variety of commodities and countries used as CF case studies, we are unable to draw simple, meaningful conclusions as to the direction of impact that many variables have on the probability of farmer participation. It seems that simple arguments such as developed versus developing, plant versus animal products, or countries in one continent versus another are insufficient for explaining the lack of general consensus within the literature. It appears that fundamental institutional or cultural differences that are perhaps country and/or commodity specific determine the relationship between the variety of explanatory factors considered in this literature, and contract participation.

These results are somewhat perplexing from a developmental policy perspective. As it is well supported that CF can improve farmers' welfare, developmental policy should focus on increasing CF participation. Yet, if the empirical literature is unable to identify generally significant motivating factors of CF participation, policy is not well informed. We return to this issue with a statistical analysis in order to further sift through the empirical studies reviewed thus far in an effort to obtain insight into possible explanations for the differences in results produced by these empirical studies.

Welfare Impacts on Farms

The fact that CF has rapidly emerged and developed implies welfare gains for firms and farms in general. The government and the public often care more about the welfare impact on farmers. We summarize the findings from the literature for developed and developing countries separately, emphasizing the latter.

There is a relatively small body of literature on the impact of CF on farmers' income in developed countries. Hu (2012) found improved returns to corn and soybean farms in the United States, but not wheat farms. This is not a surprise because the price set up in the contract is based on market price, so there should be no expected price advantages in CF. The welfare gain from involvement in CF comes instead from risk reduction and transaction cost savings (Hennessy 1996; Martin 1997; Gray and Boehlje 2005; Key 2013). Further, farmers in developed countries have negative concerns that CF may make them lose their independence (Hobbs and Young 1999; Schulze et al. 2006). No empirical estimation of such welfare impact is found, but it is reflected in the farmers' attitudes in Germany and the United States.

A large number of studies report a positive income effect from CF in developing countries, where governments and international non-government organizations (NGOs) pay more attention. These include studies on Kenya (Wainaina et al. 2012), India (Singh 2002; Tripathi 2005; Ramaswami et al. 2006; Kalamkar 2012), Senegal (Warning and Key 2002), Lao (Leung et al. 2008), Madagascar (Bellemare 2012), Nicaragua (Michelson 2013), and China (Zhu 2007; Miyata et al. 2009; Xu and Wang 2009).

The increase in farmer income from CF comes from several sources. The primary source is farmer access to the market. In many developing countries, farms are small and farmers lack education, technology, and financial resources. Their agricultural products can only be used by themselves or sold locally at low prices. CF provides the opportunity to produce and sell higher valued commodities, or the same commodities but at higher quality (Masakure and Henson 2005; Simmons et al. 2005; Bijman 2008). The second

source is farmer access to better technology and inputs provided by the contracting firms, which upgrades their productivity (Gulati et al. 2007; Leung et al. 2008; Miyata et al. 2009). The third is that farmers receive other supports – such as loans and insurance – from financial institutes, government agencies, and the NGOs when contracted (Zhu and Wang 2007; Bijman 2008; Michelson 2013).

However, in areas where the market is more developed, the income effect may not be that significant. For example, Wang et al. (2011) found in China where there exists an open market, the contract price is set at the market level and contracted farmers do not necessarily have higher profits than non-contracted farmers. The observed income effect can also be heterogeneous, not uniformly positive (Ito et al. 2012); they find it is effective only for small farms in China. Kalamkar (2012) observed that net return for non-contracted farmers is higher than those contracted in India. A study in South Africa by Freguin-Gresh et al. (2012) also found that the often identified income effect may be misleading if not taking into account endogeneity in participation (see our discussion below). Interestingly, these examples are all for three of the five major emerging economies. Hence, it is possible that CF is effective at improving farmers' income in real primitive rural areas.

Other than the income effect for farmers, market risk and transaction cost reductions are also welfare benefits to farmers as well as for firms (Wang et al. 2011). Furthermore, there are social benefits, such as empowering women in traditional culture (Raynolds 2002).

Productivity and Efficiency Impact on the Agricultural Industry

In addition to financial and social benefits, the impact of CF on productivity is also important, because it increases total welfare instead of just redistributing it among different groups. Morrison Paul et al. (2004) and Key and McBride (2007) find a positive impact of CF on productivity in the U.S. In developing countries, the agricultural sector tends to be laidback and slow in receiving technology transfers from developed countries. Advanced farming technology such as mechanization is often based on large scale farming; these techniques are difficult to apply on small scale, fragmented operations in developing countries. CF helps facilitate technology transfers and improves productivity.

Often, the processor has technical standards for the crop or livestock growers. To help growers achieve this standard, the processor may provide inputs such as seeds and chemicals for crop growers, and baby animals, feed, and veterinary assistance for livestock growers. They also provide technical training and other consulting services as part of the contract. Such production efficiency improvements are found among poultry growers in India (Ramaswami et al. 2006), Indonesia (Simmons et al. 2005) and Bangladesh (Begum et al. 2012), and dairy growers in India (Birthal et al. 2005). Studies also find crop yields increased for potato contractors in India (Tripathi et al. 2005), new technology was adopted in Lao (Leung et al. 2008), and costs decreased but output increased in China (Zhu 2007). Among all thirteen studies we found addressing production efficiency, the results consistently show a positive contribution of CF.

On top of technical efficiency, financial constraints have always prevented farms from gaining higher economic efficiency. This is especially true for small and poor farms without credit or collateral to obtain financing in developing countries. CF can help

farmers receive credit from financial institutions, and in-kind credit such as seeds, fertilizers, and other inputs directly from the firms (Simmons et al. 2005; Ma et al. 2011).

Beyond the farm gate, CF also improves the efficiency for downstream links of the supply chain. The agribusiness firms can now have a reliable supply of raw materials of their required variety and quality with less price uncertainty (Allen and Lueck 1995; Ma et al. 2011). The transaction cost is reduced through contracting (Gray and Boehlje 2005; Liu et al. 2009), and CF also protects the industry investment in research and development (Hobbs and Young 1999).

The supply chain efficiency gain can further trickle down to the consumers. The fragmented small farm operation with heterogeneous commodity quality is the main reason behind food safety problems. CF can cope with this fragmentation problem. For example, in China where farmland is not allowed to be sold and farm size is very small, CF enables farmers to pool their land and animals together. The food traceability resulting from CF can bring benefits to end consumers (Wang et al. 2013; Yu et al. 2013).

Farmer cooperatives can play an important role in CF, helping small farmers to gain more bargaining power in negotiations with large firms. This further reduces transaction costs for the firms to deal with individual farms, and improves the contract compliance rate in countries where contract violations are hard to prosecute (Guo et al. 2005; Guo and Jiang 2007; Ma and Xu 2008).

Endogeneity and Self-Selection into Contracts

There is concern that using the CF participation indicator as a binary independent variable may lead to an endogeneity problem in the impact regression, because farmers

who choose to participate may have intrinsic characteristics that lead to higher welfare. To deal with this issue, the two stage regression with instrumental variables is adopted by Key and McBride (2007) and Miyata et al. (2009); a multi-step Heckman-type selection correction model is used by Freguin-Gresh et al. (2012); and propensity score matching techniques are deployed by Ito et al. (2012). Bellemare (2012) uses a contingent valuation survey on farmers' willingness to pay for the contract instead of revealed participation. All papers continue to find a positive effect of CF on farmer welfare.

The self-selection arguments presented by these studies are compelling, and provide ample warning that future empirical research should not neglect the potential bias arising from the inclusion of a binary indicator for contract participation into a farmer welfare regression without careful thought, even though the empirical findings may not revert the direction of the results.

Contract Farming in China

So far, we have explored recent empirical research on CF across both developed and developing countries. We now focus explicitly on CF in China and the potential lessons therein. Our focus on China as a special case arises because China is a developing economy, and has a large agricultural market as well as strong government regulatory presence. Furthermore, the empirical literature on CF focusing exclusively on China is relatively large compared to that on other specific developing countries.

Because of its large population and land policy[3], the size of Chinese farms is extremely small, with an average of 0.3 acres (Wang 2013). Despite the recent rapid increase of Chinese income, rural income falls far behind urban income. In 2012, average

per capita rural income is about $1,277, only a third of its urban counterpart at $3,542 (NBSC 2013). The Chinese government has encouraged CF as a way of raising farmers' income by growing higher-valued agricultural products. Just like the Japanese One Village One Product Movement (OVOP) (Fujita 2007), the Chinese government supports village level governments to invest directly or make policies to attract private investors to invest in processing enterprises. The firms are called "dragon heads", who will process and market the branded product, and the governments will organize villagers to contract so that a significant acreage in a village, sometimes the whole village, is used to produce the particular product. Successful cases have been published extensively. For example, Yin and Jin (2007) report that 39 percent of the planted crop acreage in Hubei province is under the OVOP system, as was 62 percent of the aquaculture acreage.

From our review, we have identified several important recurring themes with regards to empirical findings in China. First, heterogeneity appears to play an important role in various facets of CF in China. Second, the Chinese CF experience has provided opportunity for empirical assessment on effects from both government support and previous CF experience on farmers' participation. Third, there exist a lot of problems in contract compliance.

While many of the CF participation studies for China reach consistent conclusions as in other countries, Miyata et al. (2009) and Ito et al. (2012) both find empirical evidence of nonlinearities in the effect of farmer demographics on the participation decision. Ito et al. (2012) also find that CF may only have a positive effect on farmer income for a certain subset of farmers. Our view is that these findings of heterogeneity

should not be taken lightly, from either an econometric perspective or a policy perspective. Specifically, evidence of heterogeneity implies econometric misspecification by assuming homogeneity, which potentially leads to a bias in econometric estimates and to erroneous policy recommendations. The policy perspective is that, especially in China, policymakers should use care to ensure that CF is encouraged only in areas in which there is specific empirical evidence that CF can increase farmer welfare, or encourage contracting with the right demographic sets of farmers.

As we mentioned previously, but reiterate here given its importance for CF in China, Guo (2005) and Zhu and Wang (2007) study both the importance of previous CF experience and government support on the contract participation. The Zhu and Wang (2007) finding that previous experience in CF leads to a higher probability of contracting indicates that the initial experience was positive. This is implicit evidence that CF has been successful at improving farmer welfare – at least in China – and is consistent with explicit econometric results of, for example, Miyata et al. (2009). This finding is also consistent with the Wang et al. (2011) finding that more risk averse farmers were less likely to participate in a contract. Since CF in China is relatively new, previous experience in contracting is valuable for future contracting participation.

Although most of the publications on government supported CF in the form of OVOP are descriptive, the Guo (2005) and Zhu and Wang's (2007) result that the presence of government support for contracting increases the likelihood a farmer chooses to contract is particularly encouraging. A direct implication of this research is that governments would be well advised to increase CF participation. It is clear that, at least

from the Chinese experience, that government policies aimed at increasing CF participation have been successful.

A low contract compliance rate has been troublesome in developing countries (Carney 1988; Reardon and Barrett 2000; Narayanan 2010), especially in China (Lei 2004; Fang and Wang 2013). Because the market prices of agricultural products have increased rapidly with Chinese income growth, farmers tend to sell their products outside the contract at a higher price. With a large number of small farms, the contract enforcement cost is high, allowing the contract breaching rate to reach 80 percent in some cases (Liu 2002). Guo (2006), Guo and Jiang (2007), Guo and Jolly (2008) and Wang et al. (2011) find the contract design with a flexible upside price and quality related price premium scheme may help facilitate contract compliance. Hence, these authors suggest that there should be a benefit sharing mechanism built into the contract, so that farmers perceive that the contract is fair. Ma and Xu (2008) find that cooperatives between farmers and the processing firms may also help with contract compliance.

Meta-Analysis

Our review thus far has focused broadly on different facets of CF across both developed and developing countries, and across different commodities. In some cases, we find a strong consensus in the empirical literature, yet in other cases, we have found mixed empirical evidence. In the latter cases, given the scope of empirical research surveyed, it is often difficult to identify common patterns across studies that report similar conclusions. To assist in these efforts, we conduct a meta-analysis along several different

dimensions of CF in order to identify factors correlated with different econometric outcomes. Meta-analysis has a long history in applied economic research as providing a statistical means of synthesizing established bodies of research, and as such providing an important complement to our existing review. See, for example, Stanley (2001) for a basic overview of meta-analyses in applied economic research.

Our focus in this study captures elements of both the participation equations and the farmer welfare equations. We focus our statistical analyses on variables in the literature whose effects on the outcome are ambiguous across studies. For example, in the papers surveyed on contract participation, farm size is found to make a positive, negative, or insignificant contribution across different studies. One aspect of our meta-analysis is to identify characteristics across studies that are associated with each empirical outcome.

Data

One key aspect of conducting a meta-analysis is the selection of the relevant literature. To maximize our sample of observations as well as ensure that our sample is not biased by the exclusion of any relevant work, we have included studies spanning developed and developing economies, different commodities, published and unpublished, and using both Chinese and non-Chinese data, given our interest in CF in China.

The dependent variables we consider are measures of the impact of farmer age, farmer education, farm size, and farm specialization on the probability of contract participation, as well as the effect of CF on farmer income. More specifically, we construct binary indicators for whether or not each study reported the a priori expected result for each regressor. For example, economists expect farmer age to be negatively

correlated with contracts participation because younger farmers are more likely to contract all else being equal. Hence, we define an indicator that takes a value of unity for each study in our analysis that reports a negative age coefficient in the participation regression. All other reported results, negative or insignificant, are classified as zero. We expect contract participation to be positively correlated with farmer education, farm size, and farmer specialization, and define these binary dependent variables accordingly. We also expect that CF increases farmer income, so we define our income dependent variable as a binary indicator that takes a value of unity for any study that reports a positive and significant coefficient on the contract variable in its farmer income regression.

The independent variables we consider include the age of the data used by each study, an indicator for whether or not the study is published, the sample size used in the regression, an indicator for whether or not the study focuses on a developing country, an indicator for whether or not the study is focused on China (i.e., uses Chinese data), and an indicator for whether the commodity of interest is an animal protein.[4] Our goal is to explore qualitative differences in the results across studies that may be attributed to differences in data used by each study, as well as systematic differences across developing or developed countries, or China.

Table 1 contains the definition and descriptive statistics for both the independent and dependent variables used in this meta-analysis. Roughly one third of the papers in our meta-analysis identify a significantly negative effect of farmer age, and a significantly positive effect of farmer education and farm specialization on contract participation. Sixty percent of the studies find that farm size significantly increases the

probability of contracting, and nearly sixty percent identify a significantly positive effect of contracting on farmer income. In terms of the independent variables, we find the average age of the data used in the literature is 8.73 years old (years between the most recent data used in the study and the year 2013), with the most recent study being 1 year old and the oldest 19 years. Fifty-four percent of these studies are published, twelve percent of which use Chinese data. The sample size ranges from 50 to 4707 observations with an average of 986. Sixty-nine percent of these studies focus on developing countries, and a quarter focus on animal commodities, such as poultry, livestock, dairy, and fish.[5]

The sample size for each meta-analysis regression varies, with largest sample size being 23 studies and the smallest 17. Since our dependent variables are binary, the ideal model is a logit regression. Given the small sample size and the data demanding maximum likelihood estimation of a logit regression, we also include ordinary least squares results from a linear probability model (LPM) to benchmark the behavior of our logit estimates.[6] We find that our estimates are consistent across both estimators.

Results

Table 2 contains the results of our five meta-regressions using both least squares (LPM columns) and maximum likelihood (Logit columns). For the LPM models, we report the estimated coefficients and their standard errors; for the logit regressions, we report the average marginal effect and its standard error obtained by using the delta method.

In our first model, we regress the farmer age indicator on six independent variables for a meta-sample of 22 empirical studies. We find that the age of the data is significantly negative in the logit model, and across both LPM and logit regressions, the

coefficient on the size of the sample is significantly positive. These coefficients indicate that older datasets are less likely to identify the negative effect of farmer age on contract participation by about 5 percent, while studies using larger samples are more likely to find such an effect by about 2 percent. The effect of farmer age on the probability of contract participation is not significantly linked to whether or not the paper is published, whether or not the paper uses Chinese data, or the type of commodity. The LPM identifies an insignificant effect of the developing country indicator, while is excluded from the logit due to non-convergence.

Model 2 is for the education equation for a sample of 23 meta-studies. Both the LPM and logit regressions have similar coefficients of determination, with only the sample size variable being statistically significant. These results indicate that studies that use larger samples are more likely to find a significantly positive effect of farmer education on contract adoption, by about 2.5 to 3 percent. The insignificance of our other independent variables indicates that the effect of farmer education on the probability of contracting is not systematically related to any of these variables.

The farm size indicator meta-regression has a sample of 20 studies. The LPM model finds that sample size is the only factor that is significantly related to the empirical finding that larger farms tend to contract, while it is insignificant in the logit regression. In the logit regression, we find that the age of the data is significantly negative. No other independent variables are found related to the variation across empirical studies regarding the impact of farm size on contract participation. Again, the coefficients of determination are similar across models.

The final meta-study regarding contract participation is a regression of the specialization indicator on a set of six independent variables with 17 observations. We omit the animal protein indicator since including this indicator renders the likelihood function ill-posed in this specification. We find in the LPM regression that studies focused on animal protein commodities are significantly less likely to find a significant specialization effect, of about 60 percent. This is the only regression for which this variable is statistically significant; we do not find that sample size is a significant factor explaining these empirical results. We do not find any statistical significance in the logit regression, indicating that the studies that have reported a significantly positive effect of farmer specialization on the contract participation decision do not vary systematically along the dimensions we consider here.

The last meta-regression examines study characteristics that affect the discovered income effect of CF. The sample contains 17 meta-studies. We drop the developing country indicator from both regressions since it renders our likelihood function ill-posed in the logit case, and both regression estimators return marginal effects larger than unity (indicating probability changes greater than unity). We find that Chinese studies are significantly less likely to identify a statistically significant income effect of CF in the logit model, by nearly 40 percent. We do not find that any of the other factors considered are significantly related to the income effect in empirical CF studies.

Discussion

Looking across each of the five meta-regressions we conduct, it is clear that larger samples are often significantly related to the recovery of an empirical result that is both

consistent with prior expectations in sign, as well as statistical significance. We also find some evidence that the age of the data may be an important driver of some of the conflicting empirical results identified in our detailed review. For the age and size impacts on contract participation, the data age show a significant and negative effect, which means analysis using more recent data support our prior expectation. However, the data age factor is insignificant for the income equation, which indicates that studies using more recent data are not more likely to find a significant income effect.

It is interesting to notice the insignificance of the other regressors in most other models. In particular, for the models that include the developing country indicator, we do not find any statistical significance of this indicator. At least, this finding clearly implies that conflicting results in empirical studies do not conflict simply because of differences across developed and developing countries. This is consistent with our review of the empirical literature that indicated that there may be important differences within developing countries, and that a simple developed versus developing country argument does not suffice in explaining these differences. Yet, everything else the same (for the independent variables we use as controls), we might interpret the insignificance of the developing country indicator as evidence of intrinsic similarities in both types of countries with respect to CF. It is also clear that animal based commodities are not significantly different from other (plant based) commodities.

It is interesting to note that differences in empirical studies are not driven solely because of differences between Chinese and non-Chinese data, or by whether or not the research is published. The latter is reassuring because it indicates that there is not a

significant publication bias that sometimes arises in empirical research. The former result is interesting because it indicates that China may not be systematically different from other countries, at least in terms of CF. This further buttresses our consideration of China as a representative developing country in terms of CF.

The lesson learned from our meta-analysis of the existing empirical literature is clear: factors contributing to farmer contract participation are not very different across developed versus developing countries or commodities. More recent studies and those using larger samples tend to give us results consistent with conventional knowledge. There is still ample room for future empirical research to focus more heavily on particular countries or commodities to further our collective understanding of these facets.

Conclusion

Recent years have seen movement of contract farming to developing countries, followed by a large body of empirical research aimed at quantifying many effects of CF on farmer welfare. In many studies, explicit attention is given to the understanding of why some farmers choose to contract, while others do not. This body of research has focused widely across both developed and developing countries, as well as commodities.

In some instances, the empirical literature has drawn clear conclusions. For example, most contract participation studies find that neither the number of laborers employed on the farm nor farm assets contribute effectively to contracting, but that government policies that encourage contracting are effective drivers of contract adoption. Our review has also shown that farmer selection into contracts is likely non-random.

These clear conclusions are important because they indicate stability across countries and commodities of CF along these important dimensions.

Another consensus among countries and commodities is that CF has a significant effect on improving farm efficiency as well as the efficiency of the supply chain. While segmented small operations are pooled together when contracting with a large firm, they can use larger equipment, adopt state of the art technology in production, reduce transaction cost in the supply chain, and make food traceable. This indicates that CF can serve as a vehicle to modernize small farm based agriculture in developing countries.

In other cases, researchers have been unable to draw clear conclusions across either countries or commodities. As we have described, the reason for this lack of consensus on certain facets of CF may stem from heterogeneity across countries and/or commodities. For instance, some cultural or institutional factors may be unique across countries; similarly, these same factors may have heterogeneous impacts on different commodities within a particular country. In China, for example, the literature is clear that risk averse farmers are less likely to contract because of general unfamiliarity of Chinese farmers with contracting. This finding, however, need not be true outside of China. Further evidence of heterogeneity comes from studies that have reported statistically significant nonlinearities with respect to the effects of education and farmer experience on contract adoption, as well as the effect of contracting on farmer income.

To address some of these issues, we develop a brief meta-analysis of the existing research as a means of identifying systematic differences across studies that may drive differences in empirical findings. We find that the age of the regression sample and the

size of the dataset are significantly correlated with the identification of statistically significant empirical results that are consistent with a priori expectations. It is also clear from our meta-regressions that the empirical differences culled from the existing literature are not easily explained by simple comparisons of developed and developing countries, or plant and animal commodities. The insignificance of these indicators confirms our intuition culled from the available empirical research, and further strengthens this intuition given our control of other factors.

Through this review and statistical analysis of the existing literature, several important insights have been made clear. First, CF is largely successful in improving farmer welfare. From a developmental perspective, this bears important implications because policymakers can be reasonably assured that investment of resources into developing CF is a fruitful policy venture. Second, our review has described which aspects of farmer contract participation are generally significant, and which are somewhat contentious. Third, our meta-study has made clear that with the exception of larger, more recent samples, there does not appear to be systematic differences across developing/developed countries or commodities.

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Table 1: Descriptive Statistics

	Description	Mean	Std Dev	Min	Max
Binary Dependent Variables					
Age	Indicator, =1 if age negative/significant	0.36	0.49	0	1
Education	Indicator, =1 if education positive/significant	0.30	0.47	0	1
Farm Size	Indicator, =1 if farm size is positive/significant	0.60	0.50	0	1
Specialization	Indicator, =1 if specialization positive/significant	0.29	0.47	0	1
Income	Indicator, =1 if contracting increased farmer income	0.59	0.51	0	1
Independent Variables					
Data Age	Age in years of most recent data used in study	8.73	4.18	1	19
Published	Indicator, =1 if the article is published in a journal	0.54	0.51	0	1
Sample Size	Sample size used in regression	986	1387	50	4707
Developing Country	Indicator, =1 for developing country study	0.69	0.47	0	1
China Data	Indicator, =1 for data collected from China	0.12	0.33	0	1
Animal Protein	Indicator,=1 if the commodity is fish, poultry, livestock or dairy	0.23	0.43	0	1

Table 2: Impact of Study Characteristics on Contract Farming Empirics: Results from Meta-Analysis Regressions

	Age		Education		Farm Size		Specialization		Income	
Variable	**LPM**	**Logit**	**LPM**	**Logit**	**LPM**	**Logit**	**LPM**	**Logit**	**LPM**	**Logit**
Data Age	-0.017	-0.054*	-0.011	-0.004	-0.062	-0.061+	0.043	0.032	0.027	0.033
	(0.034)	(0.029)	(0.038)	(0.031)	(0.047)	(0.035)	(0.035)	(0.029)	(0.034)	(0.030)
Published	-0.239	0.109	0.197	0.247	0.309	0.302	-0.169	0.090	0.112	0.161
	(0.311)	(0.294)	(0.268)	(0.220)	(0.335)	(0.257)	(0.332)	(0.229)	(0.344)	(0.264)
Sample Size	0.027**	0.020**	0.024**	0.032*	0.017+	0.026	-0.005	0.003	0.002	0.001
	(0.010)	(0.008)	(0.011)	(0.018)	(0.011)	(0.024)	(0.012)	(0.011)	(0.011)	(0.009)
Animal Protein	-0.032	0.098	0.156	0.242	-0.334	-0.262	-0.630+		-0.127	-0.137
	(0.300)	(0.337)	(0.317)	(0.272)	(0.286)	(0.197)	(0.396)		(0.375)	(0.267)
Developing	0.514		0.125	0.469	0.073	0.181	0.317	0.227		
	(0.355)		(0.346)	(0.505)	(0.416)	(0.589)	(0.385)	(0.363)		
China Data	0.226	0.155	-0.103	-0.025	-0.144	-0.180	-0.215	0.003	-0.384	-0.388+
	(0.276)	(0.201)	(0.270)	(0.223)	(0.292)	(0.225)	(0.385)	(0.305)	(0.348)	(0.259)
Constant	-0.005		-0.056		0.837		0.040		0.428	

Table 2: Impact of Study Characteristics on Contract Farming Empirics: Results from Meta-Analysis Regressions

Variable	Age		Education		Farm Size		Specialization		Income	
	LPM	**Logit**	**LPM**	**Logit**	**LPM**	**Logit**	**LPM**	**Logit**	**LPM**	**Logit**
	(0.464)		(0.540)		(0.589)		(0.505)		(0.472)	
n	22	22	23	23	20	20	17	17	17	17
R^2	0.436	0.349	0.344	0.325	0.436	0.421	0.314	0.118	0.272	0.237

Table reports marginal effects and standard errors for least squares and logit regression models. Logit marginal effects are average marginal effects, and standard errors are the standard errors of the marginal effect obtained via the Delta method. Statistical significance at the 1%, 5%, 10%, and 15% levels are denoted by ***, **, *, + respectively. Further regression output details are available upon request.

[1] Although cash forward contracts for a few major agricultural commodities have existed for a long time in developed countries, they are not the same as contract farming because the latter tend to be for specialty crops or commodities with special quality features that do not have a liquid open market.

[2] Some contracts also provide farmers with a means of obtaining loans. This provides further motive for credit constrained farmers to participate in a contract.

[3] Farm land is not owned by individual farmers, and thus the ownership cannot be transferred. Farmers have the use right.

[4] We explored more detailed indicators for commodity type, separately identifying field crops, vegetables, and animal products from a base group of other products. We found that this level of division rendered our likelihood function ill-posed in our logistic regressions, so we report only those results from division of commodity based on animal protein.

[5] We also tried to further separate the plant based commodities into field crops and horticultural crops. The results do not show any significance and cause some convergence failure in maximum likelihood estimation.

[6] We also explored defining our dependent variables across negative, positive, and insignificant separately and estimating the model as a multinomial logit. These results are generally qualitatively consistent with the binary logit results reported here, and are hence omitted.