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Working Paper

Capitalization of agricultural subsidies into land prices

EERI Research Paper Series, No. 09/2020

Provided in Cooperation with:

Economics and Econometrics Research Institute (EERI), Brussels

Suggested Citation: Ciaian, Pavel; Baldoni, Edoardo; Kancs, D'Artis; Drabik, Dušan (2020) : Capitalization of agricultural subsidies into land prices, EERI Research Paper Series, No. 09/2020, Economics and Econometrics Research Institute (EERI), Brussels

This Version is available at:

<https://hdl.handle.net/10419/251101>

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EERI Research Paper Series No 09/2020

ISSN: 2031-4892



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The Capitalization of Agricultural Subsidies into Land Prices¹

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When citing this paper, please use the following: Ciaian, P., E. Baldoni, D. Kancs and D. Drabik 2021. "The Capitalization of Agricultural Subsidies into Land Prices". Annual Review of Resource Economics, 13: Submitted. doi.org/10.1146/annurev-resource-102020-100625

¹ Dusan Drabik acknowledges the financial support received from the Slovak Research and Development Agency under contract No. APVV-19-0544 and from the Operational program Integrated Infrastructure within the project: Demand-driven research for the sustainable and innovative food, Drive4SIFood 313011V336, co-financed by the European Regional Development Fund. The authors are solely responsible for the content of the paper. The views expressed are purely those of the authors and may not in any circumstances be regarded as stating an official position of the European Commission.

Abstract

We review the recent theoretical and empirical literature on the capitalization of agricultural subsidies into land prices. The theoretical literature predicts that agricultural subsidies are capitalized into land prices when land supply is inelastic and land markets function well. The share of capitalized subsidies significantly depends on the implementation of farm subsidies, local land-market institutions, rural market imperfections, and spatial effects. Most empirical studies have shown that agricultural subsidies are only partially capitalized into land prices, estimating that decoupled payments and land-based subsidies exhibit higher capitalization than coupled payments and non-land-based subsidies, respectively. However, estimated capitalization rates vary widely across studies largely because of data availability and identification challenges.

Keywords: agricultural subsidies, capitalization, land prices, land rents, land values, land market, coupled and decoupled payments

1. INTRODUCTION

Agriculture is one of the most heavily subsidized sectors globally, particularly in developed countries. According to the producer support estimate (PSE) estimated by the Organization for Economic Co-operation and Development (OECD), annual gross transfers to farmers totaled between 223.6 and 272.6 billion United States (US) dollars in OECD countries from 2010–2017. The European Union (EU) took the lion's share of the OECD total (more than 40%) over the same period, followed by Japan (15–23%) and the US (11–17%). Developing countries tend to support agriculture less or even tax it, although subsidization has been rising in some developing countries over the last few decades (Anderson et al. 2013). For example, the total PSE in 2017 reached -2.0, 3.5, and 9.9 billion US dollars in Ukraine, Brazil, and Russia, respectively. China stands out as the single most important non-OECD farming supporter, with a PSE ranging from 103.9–236.1 billion US dollars from 2010–2017 (OECD 2020).

A primary objective of agricultural subsidies is to increase farmers' income. While most agricultural subsidies target farmers, evidence suggests that they may not be the only beneficiaries of such transfers. The capitalization of subsidies into farmland prices² is considered a major channel of subsidy leakage outside the farming sector and is intensively debated in the academic literature and among stakeholders.³ The key concern is that if subsidies result in higher land prices, they might indirectly accrue to non-farming landowners at the expense of tenant farmers and new entrants into farming. Therefore, subsidy capitalization is central when evaluating the transfer efficiency of agricultural support.

² We use land prices as a reference to both land rental prices (rents) and land (sale) prices (value). The land rental price represents the price of renting one hectare of land annually from its landowner. The land sale price (value) per hectare of land usually refers to the market sale or purchase value of the land.

³ The capitalization of subsidies refers to the extent to which subsidies affect land prices (i.e., rents or land values). It can be described by several measures, of which the three most important are (i) the capitalization level, which is usually expressed in monetary terms (change in land price in euro per one euro of subsidy change), (ii) the capitalization rate, which is usually expressed as a percentage representing the share of subsidies reflected in higher land prices, and (iii) the elasticity form (capitalization elasticity) expressed as the percentage change in the land price per percentage change in subsidies.

From a policy perspective, the capitalization of subsidies is particularly relevant when a large portion of farmland is rented. For example, on average, around 40% and 50% of farmland is rented in the US and EU, respectively. However, important regional differences in land renting exist because of the heterogeneity of the land-market structure. In the US, the Midwest and Plains regions are associated with the highest percentages of rented land at 46% and 43%, respectively, while the Northeast and West regions have the lowest renting at around 29%. In the EU, the share of rented land varies between 18% in Ireland and 91% in Slovakia (Bigelow et al. 2016, Ciaian et al. 2018). These variations affect the extent to which farmers and non-farming landowners can capture policy rents.

A rich literature investigates the capitalization of agricultural subsidies that dates back to Floyd (1965), who developed a stylized perfect competition model to explore the impact of agricultural support on farm input prices analytically. Floyd's theoretical framework was later extended by relaxing certain assumptions and considering different subsidy types and their implementation modalities (e.g., Gardner 1987, Hertel 1991, Leathers 1992, Dewbre et al. 2001, Alston and James 2002, Schmitz and Just 2002, Guyomard et al. 2004, Ciaian and Swinnen 2006, 2009, Ciaian et al. 2008, Kilian and Salhofer 2008, Graubner 2018).⁴ The first empirical studies of the capitalization of agricultural subsidies emerged in the US in the 1960s and 1970s (e.g., Hedrick 1962, Seagraves 1969, Vollink 1978). In Europe, the empirical literature emerged more than two decades later and has mainly investigated the EU's Common Agricultural Policy (CAP) (e.g., Goodwin and Ortalo-Magné 1992, Duvivier et al. 2005, Pyykkönen 2005, Patton et al. 2008, Latruffe et al. 2008). Overall, the vast majority of the available empirical literature focuses on developed countries (particularly the US and EU); empirical studies on developing countries are scarce (e.g., Zhang et al. 2020).

The paper is organized as follows. The following section provides a review of the theoretical literature on the capitalization of agricultural subsidies into land prices and the gaps that the literature has insufficiently addressed. The third section summarizes the estimated capitalization rates in the empirical literature. The fourth section discusses the problems identified in empirical studies. The last section draws conclusions and discusses implications for future research.

2. THEORY

The canonical theoretical framework for analyzing subsidy capitalization into farmland prices is the perfect competition model of Floyd (1965), which was extended and refined by later studies, such as Gardner (1987), Alston and James (2002), and Schmitz and Just (2002). According to this model, the primary determinants of subsidy capitalization are input supply elasticities, output demand elasticity, and factor substitution elasticity. The model predicts that policy gains are typically shared across multiple agents operating in agricultural markets, including producers (farmers), suppliers of land and non-land inputs, and consumers. Landowners are expected to benefit from subsidies through their capitalization into land prices. Subsidies usually affect land

⁴ This literature belongs to the wider field of welfare impacts (incidence) and transfer efficiency analyses of agricultural policies (Bullock et al. 1999, Sumner et al. 2010).

prices and other prices (e.g., output and non-land input) and hence may also leak to other agents operating in agriculture.

The model implies that the less elastic the supply of an input, the more capitalized the subsidies into prices of that input. Due to natural constraints, land supply is less responsive to price changes than non-land inputs, implying that land prices are expected to capture a substantial share of farm subsidies (Abler 2001, Salhofer 2001).

The focus of the early theoretical literature was on standard agricultural subsidies, such as those linked to farm inputs and outputs (both land and non-land). The perfect competition model predicts the capitalization of land subsidies to be greater than the capitalization of non-land subsidies and output subsidies to be more capitalized than non-land input subsidies. Subsidies can be fully capitalized into land prices and thus entirely accrue to landowners only under extreme parameter values. Land subsidies are predicted to accrue entirely to landowners under a completely fixed land supply, independent of the values of other elasticities. Non-land subsidies can be fully capitalized into land prices if land supply is perfectly inelastic, and either non-land input and output demand are perfectly elastic or factor input shares are fixed (i.e., the factor substitution elasticity is also zero).

For illustrative purposes, assuming reasonable values of supply and demand parameters, the perfect competition model (as derived by Alston and James in 2002) predicts the capitalization rate of standard land subsidies to be substantial (between 60% and 100%) for moderate values of land supply elasticity (0.1 or lower) and to decrease significantly with land supply elasticity (e.g., it may more than halve at an elasticity of 0.3). The predicted capitalization rate of standard non-land subsidies is significantly lower, ranging between 6% and 62% (Supplemental Appendix).

The standard types of subsidies analyzed by early theoretical models often differ from real-world situations, however, and perfect competition assumptions may not always hold in reality, leading to possibly inaccurate capitalization effects. Recently, the theoretical literature has relaxed certain assumptions of the canonical model and extended the analysis, among others, to different types of subsidies, implementation details, market imperfections, and spatial effects, which – as we discuss below – matter for their capitalization.

2.1. Subsidy Types and Implementation Details

Most developed countries implement subsidies in complex policy frameworks, as they often combine multiple instruments and are subject to conditionality and eligibility rules determining under what conditions beneficiaries can receive them. This increased complexity of agricultural subsidies largely reflects the evolution of agricultural support, particularly in developed countries, from rather distortive coupled instruments that affect farmers' production decisions and market signals (e.g., market price support) to more complex, decoupled transfers often also targeting

market failures and market imperfections (e.g., the environment in the EU, risk in the US) (Melendez-Ortiz et al. 2009, Swinnen 2015).⁵

Following agricultural policy developments, the most recent theoretical literature relaxes some assumptions about the implementation rules of subsidies (e.g., Guyomard et al. 2004, Kilian and Salhofer 2008, Ciaian et al. 2008, 2014, Courleux et al. 2008, Gocht et al. 2013, Ciaian et al. 2018) and shows that they are crucial in determining whether subsidies affect land prices and which implementation rules matter. For example, the theoretical literature has shown that for the EU land-based subsidy – the Single-Payment Scheme (SPS) – capitalization rates can vary from 0–100% depending on the implementation details. The main intuition behind this result is that in a system with payment entitlements, such as that of the SPS – where to cash in the subsidy, each right of the entitlement must be accompanied by a corresponding area of the eligible farmland – the relative availability of entitlements influences the demand for land and, eventually, the capitalization rate. Depending on policy implementation modalities, fewer or more entitlements may be allocated than eligible hectares. Assuming a fixed land supply, given more entitlements than the eligible area, the capitalization rate is expected to be 100% (i.e., the same as for the standard land subsidy). However, given fewer entitlements than the eligible land, the land capitalization rate may fall to zero, and the subsidy is capitalized into the price of the entitlement instead. If the entitlement is not transferable, the subsidy might become capitalized even if there are fewer entitlements than the corresponding eligible area. If the value of the land-based subsidy varies across farms (as is the case with the EU’s SPS), it results in less-than-full subsidy capitalization, even with a fixed land supply and with more entitlements allocated than the eligible land.⁶

Alternatively, if land-based subsidies target landowners instead of farmers, they are not capitalized into land prices, but landowners benefit from them regardless of whether the total number of allocated entitlements is less or greater than the corresponding eligible area.⁷

The realization of some support systems (e.g., counter-cyclical payments and marketing assistance loans in the US) depends on yield and market outcomes, making the identification of capitalization effects not straightforward. The incurred payments of this support may not be ex post detectable under good market conditions (e.g., high output prices, yields, and revenue, depending on the implementation) because payments are not incurred when market values are

⁵ The literature distinguishes between “coupled” and “decoupled” subsidies. Coupled subsidies are the type of policy instrument that depend on output levels and thus affect farmers’ production decisions and incentives in agricultural markets. Examples of coupled subsidies include market price support, output subsidies, and fertilizer subsidies. Decoupled subsidies are less distorting support that is (directly) independent of farmers’ production choices, output levels, and market conditions and could include, for example, fixed income transfers and coupled payments linked to past production (World Bank 2003, Westcott and Young 2004). Land-based subsidies are usually considered decoupled payments because they are expected to have a minimal impact on farmers’ production (Sckokai and Moro 2009).

⁶ Additionally, if the land-based subsidy is conditional on fulfilling environmental requirements, as is the case of the SPS, the capitalization rate might become negative (e.g., when there are fewer entitlements than the eligible land and environmental requirements generate additional costs to farmers).

⁷ There are not many real-world examples of subsidies paid to landowners, but some EU countries implement imperfect land-based subsidies, such as the SPS and SAPS (Single-Area Payment Scheme). Despite the EU regulations requiring that only farms can receive subsidies, in several EU countries, non-farming landowners have applied for and received them (Ciaian et al. 2010, 2014, European Court of Auditors 2012).

higher than their policy-determined targets. Alston and James (2002) argued that the ex-ante anticipated support (i.e., the probability that the support will be applied) before market conditions are realized is what matters, not the actual ex post realization of the support. This implies that capitalization is a function of ex ante expected support and indirectly depends on expected market outcomes.

A growing number of studies have considered the complexity of agricultural subsidies and have found that the major types of subsidies implemented in the EU and US impact the capitalization rate (Innes and Rausser 1989, Guyomard et al. 2004, Kilian and Salhofer 2008, Ciaian et al. 2008, 2014). Despite these theoretical advances, several subsidy types and certain aspects of the implementation mechanics (also for the major subsidy types) remain inadequately examined or understood in the theoretical literature. This concerns, among others, many smaller types of policy support (e.g., public research and development programs, credit and insurance programs, and rural development programs), subsidies peculiar to developing countries (e.g., extension service programs and support for adopting new farm practices and technologies), and non-automatic types of support (e.g., investment support and agri-environmental payments in the EU; loan programs and payments for environmental services in China; and the Conservation Reserve Program in the US). The conditionality and eligibility rules of more complex subsidies are also not fully investigated in the literature (e.g., the conditionality of the SPS on fulfilling environmental requirements in the EU).⁸

The key issue of non-automatic support is the self-selection of eligible farms into the program because the support is not granted to all eligible farms but is subject to voluntary participation and project approval. The self-selection implies that the capitalization rate may vary significantly across farms depending on the policy support selection criteria and the voluntary choices of farmers to participate.⁹

2.2. Land-Market Institutions

Most theoretical studies investigating subsidy capitalization have applied perfect competition models by assuming that land prices adjust instantly and completely to market signals. However, inertia is a common phenomenon in land markets because of land-market regulations, contractual rental arrangements, and social norms (Alston 2010, Hendricks et al. 2012).

Land-market regulations vary significantly across countries, ranging from a liberal approach with limited interventions in land markets (e.g., Australia, Finland, Germany, Sweden, the UK, and the US) to a strict regulatory system (e.g., France, Hungary, Norway, and Japan). Various aspects of rental markets, sales markets, or both can be regulated. In general, land-market regulations are expected to reduce the capitalization of subsidies because they may make land transactions more costly, depress land-market competition, or restrict land price adjustments

⁸ For example, Ciaian et al. (2014) investigated how the environmental conditionality of EU land-based subsidies (e.g., the SPS) impacted rental prices. The weakness of their approach was that they did not explicitly model the environmental requirements but only applied a reduced-form model, which might have biased the derived capitalization effects.

⁹ For example, the capitalization is expected to be different as compared to the case of a random disbursement of support to eligible farmers.

(Ferguson et al. 2006, Alston 2007, Davies et al. 2007, Swinnen 2002, OECD 2009, Ciaian et al. 2010, 2017, Forbord et al. 2014, Swinnen et al. 2014a, 2014b).

Even in the absence of land-market regulations, rental arrangements between landowners and tenants can interact with land prices and thus impact subsidy capitalization. Rental arrangements include different terms and conditions agreed upon by tenants and landowners (e.g., rental duration and price setting, the degree of landowner involvement in management decisions and cost-sharing, and the recipients of subsidies). Generally, adjustments of the capitalization of subsidies into land rents are expected to be more gradual, with long-term rental contracts.

Studies have shown that social norms, such as trust, customs, and fairness, are pivotal drivers of rural land markets and transaction types (e.g., Patterson et al. 1998, Rainey et al. 2005), land prices (Robison et al. 2002), and transaction partners (Siles et al. 2000). In many rural regions, land transactions depend on the relationships between the parties involved (e.g., landlord and tenants and the durations of their relationships) and tend to occur mainly between relatives or neighbors. According to Robison et al. (2002) and Tsoodle et al. (2006), this group of land-market participants may receive rebates on land prices from 6–43%. These aspects of social norms are expected to depress the capitalization of subsidies because they affect land price formation.

The existing literature typically presumes that land-market institutions reduce or delay the transmission of changes in subsidies into land prices. However, the literature does not formally derive how land-market institutions affect subsidy capitalization, the expected duration of delays in land price responses to subsidies, long-run capitalization rates after markets have adjusted, or whether long-run capitalization rates differ from the rates predicted under other types of land market–competition assumptions. A dynamic modeling framework might be required to capture the way land-market institutions affect capitalization in contrast to the static models predominantly used in the literature.

2.3. Market Imperfections

Agricultural markets exhibit different imperfections linked either to competition (including downstream and upstream stages) or incomplete rural markets – labor, land, credit, and risk. While imperfect competition is equally relevant to both developed and developing countries, incomplete rural markets are likely to be more pervasive in developing countries.

In general, the literature suggests that imperfect competition tends to reduce subsidy capitalization. Retailers, processors, and other input suppliers with significant market power may capture relatively large shares of the benefits of agricultural subsidies instead of landowners (e.g., McCorriston and Sheldon 1991, Salhofer and Schmid 2004), implying that their capitalization into land prices might be lower. Even the capitalization of land subsidies, which is expected to be high due to inelastic land supply, may be small in imperfectly competitive markets. For example, Graubner (2018), who modeled spatial competition (local farmers' market power)¹⁰ in land rental markets, showed that the capitalization of land subsidies was significantly lower even if the local

¹⁰ Farmers' market power may be reinforced by farm consolidation and growth observed over time in most developed countries (Kirwan 2009, Neuenfeldt et al. 2018).

land supply was fixed (thus rejecting the full capitalization predicted by the perfect competition model).

Incomplete rural markets may bring in additional channels through which agricultural subsidies affect farmers' production decisions and thus potentially alter subsidy capitalization. Among others, subsidies may address market imperfections themselves (i.e., may improve welfare) or alter agents' responses compared to complete, perfect market situations (Moschini 1984, Innes and Rausser 1989, Hennessy 1998, Ciaian and Swinnen 2009). For example, Hennessy (1998) suggested that under uncertainty – even if decoupled from production – subsidies may affect farmers' wealth and risk attitudes, making them more willing to expand production activities that they would otherwise view as too risky (Roche and McQuinn 2004). Similarly, Innes and Rausser (1989) showed that with risk-averse farmers and incomplete insurance markets, the US target price/deficiency payments may increase supply. Although these studies did not usually derive explicit implications for land prices, their results imply that the production expansion and changes in the market return to affect the capitalization of policy support. The analyses of Innes and Rausser (1989) suggested that the impact on production could be substantial so that the distributional effects could be reversed. Ciaian and Swinnen (2009) showed that land rents may rise by more than the value of land subsidies when farmers are credit constrained – implying a capitalization rate greater than 100% – because subsidies may alleviate financial constraints for credit-rationed farms.¹¹

Ultimately, how rural markets affect the capitalization of subsidies is challenging to predict a priori in existing theoretical models due to many simultaneous confounding factors. Among others, it depends on the type of market imperfections, their magnitude, how they interact across different subsidies, and the behavioral responses they generate. For example, the capitalization of non-automatic support where eligible farmers self-select into program participation (e.g., EU investment support) may completely differ under alternative credit market conditions. If credit markets are complete, non-automatic investment support may crowd out contemporaneous or inter-temporal private investments within or between farms, inducing insignificant market impacts (including insignificant land price effects) (Harris and Trainor 2005, Bronzini and de Blasio 2006). For example, Michalek et al. (2015) estimated that the within-farm crowding-out effect of farm investment support was close to 100% in Germany, suggesting the insignificant market impacts of subsidies. Moreover, if investment support crowds out the private investments of more productive farms, the net aggregate productivity effect of the support could be negative and reduce land prices. However, if the support recipients are credit constrained, the investment support is expected to alleviate farms' credit constraints and thus potentially improve their productivity and possibly raise land prices (Brandsma et al. 2013).

Overall, the existing literature provides only partial answers about selected subsidies and the expected effects of market imperfections (e.g., Graubner 2018), not a full understanding of how

¹¹ The effect of the credit channel on capitalization is expected to increase with the magnitude of the credit constraint and decrease with the availability and profitability of alternative uses of subsidies (e.g., off-farm investment, farm-household consumption) (Chambers and Voica 2017).

these imperfections affect the capitalization of different (real) subsidies and which market imperfections are the main drivers.

2.4. Asymmetric Information About Subsidies

The literature often argues that land prices may incompletely reflect agricultural subsidies because of incomplete information among land-market participants as regards the actual value of subsidies (which is particularly relevant to non-farming landowners). Imperfect knowledge could arise due to the information costs and design of the support, especially when the heterogeneity of a subsidy among recipients is large. For example, in the EU, land-based SPS payments are farm-specific under some implementation modes, implying that their levels may not be fully known to all market participants. Although this issue has not been formally investigated in the literature, incomplete information about subsidies may impede landowners or farmers in negotiating the best land prices (Alston 2007).

Information asymmetry about subsidies is expected to affect the capitalization rate, particularly given other land-market imperfections or if farmers (e.g., new entrants) have incomplete information.¹² If, however, farmers have good knowledge about subsidies and land markets are competitive, subsidies may still be capitalized into land prices even if landowners have imperfect information about their levels. Consider the land-based subsidy, for instance. Rational farmers have an incentive to use as much land as possible to maximize their benefits. The competition for land pushes up land prices, reflecting their marginal return (including the subsidy). The competition between farmers for the land is enough to drive prices up because it reduces the farmers' informational advantage; full knowledge about the levels of subsidies is not required from the landowners' side (Cabrales et al. 2011). Satterthwaite and Shneyerov (2008) showed that in a decentralized, dynamic, competitive market (with many buyers and sellers) with an infinite horizon and incomplete information between buyers and sellers, the steady-state equilibria converge to the Walrasian prices and competitive allocations.

2.5. Rental Prices Versus Sale Values and the Role of Expectations

Theoretical studies have chiefly analyzed the capitalization of subsidies into rental prices, not capitalization into sale values (Kilian and Salhofer 2008, Kilian et al. 2012). To the best of our knowledge, no theoretical studies have compared how the subsidy capitalization rate differs between land values and rents, which may not necessarily be the same in reality.

Usually, the literature assumes farmland value to follow the net present value (NPV) model, where the current value of land is represented by the sum of discounted expected future returns to land (Weersink et al. 1999, Goodwin et al. 2003). Under this framework, the key difference between rents and land sale values lies in the role of expectations about future land returns. According to the NPV model, land values are determined by expectations about the long-run stream of returns (both market and policy-induced) from agricultural land. In contrast, rents are annual payments paid as compensation for farmland services, reflecting annual (market and policy-induced) returns to land. Thus, there is an inherent difference in planning horizons between

¹² This assumes that farmers receive the subsidy.

these two price measures that involves facing different risks and opportunity costs between renting and purchasing land (Clark, Fulton and Scott 1993). This difference implies that the subsidy capitalization into rents and land values may differ and that it may not necessarily be possible to use one of them to predict the capitalization of the other.

The capitalization of subsidy into land values and rents would be the same only if subsidies were expected by land-market participants to be permanently available in the future. In contrast, the capitalization of land values and land rents would differ if subsidies were seen as transitory payments or were expected to change in the future.¹³ For example, if the prevailing expectations of market participants are a decrease (or an introduction of more stringent eligibility or conditionality rules) of subsidies in the future, the current capitalization rate into land values is expected to be smaller than the capitalization rate into rents (Latruffe and Le Mouél 2009, Weersink et al. 2009).

Expectations about the future continuation of subsidies may also affect subsidy capitalization into land rents if rental contracts are not negotiated annually but are fixed over longer periods, which is usually the case in long-term tenancy arrangements (Alston 2007, Kirwan 2009, Kropp and Peckham 2012).

A further difference in the capitalization rate between rents and land values is that the latter may be strongly influenced by expected future land returns from non-agricultural uses, such as urban development, industry land demand, recreational and natural amenities, and different location-specific drivers. If land values are influenced significantly by non-agricultural factors, they may become (partially) disconnected from subsidies, which may lead to lower capitalization rates – even if future subsidies are expected to stay unchanged – unlike when non-agricultural factors play a more marginal role (or unlike land rents) (Plantinga and Miller 2001, Goodwin et al. 2003, Borchers et al. 2014, Delbecq et al. 2014).¹⁴

If market imperfections interact differently with land sale markets than rental markets, differences in the subsidy capitalization between land values and rents may also arise. For example, in addition to the credit channel shown by Ciaian and Swinnen (2009) that increased subsidy capitalization into land values and land rents (i.e., valid for both tenant farmers and farming landowners), a second credit channel may be present for farming landowners. If the land is used as collateral for credit and if subsidies increase land values, landowners' access to bank credit improves regardless of whether they are subsidy recipients (Shalit and Schmitz 1982), which may stimulate their productivity growth and further increase land value. This second channel is present only if farmers are also landowners and impacts primarily only land values because land ownership generates an additional value to farmers by increasing their access to land-collateralized credit.

¹³ The drivers of subsidy change vary from country to country, but the key ones are budgetary constraints, international agreements, and political pressures from interest groups (e.g., Becker 1983, Swinnen 1994, Swinnen et al. 2001). These drivers contribute to the formation of land market participants' expectations about the future continuation or change of subsidies.

¹⁴ For example, if land-market participants expect a future conversion of land into non-agricultural uses, agricultural subsidies might become (partially) disconnected from land values but may still influence rents, at least in the short run.

2.6. Spatial Variation of Subsidy Capitalization

The immobility of land combined with the imperfect mobility of farmers may result in spatial market segmentation and consequently induce a spatial variation of subsidy capitalization. Spatially segmented rural land markets – as observed in most developed countries/regions – imply that a spatial market equilibrium cannot be attained across different locations; that is, “the law of one price” does not hold across locations. Spatially differentiated dynamic effects might arise in the presence of a spatial dependence, that is, when economic effects occurring in one location affect other locations in combination with spatially heterogeneous structural factors (e.g., competition level, non-agricultural drivers, land-market institutions, and market imperfections) (Patton and McErlean 2003, Adenäuer et al. 2016).

Generally, the impact of spatial aspects on subsidy capitalization has been largely ignored in the theoretical literature. A notable exception is Graubner (2018), who develops a spatial model of the farmland market that assumes land to be a spatially differentiated input due to transportation costs. He showed that if the spatial dimension (i.e., reduced competition) of the market is substantial enough, the capitalization of land subsidies into rents is low or zero and varies geographically depending on the spatial variation of market competition, among other things.¹⁵

A spatially differentiated subsidy capitalization may occur, even in the absence of distance costs, when non-agricultural demand for land is spatially heterogeneous, which is a common driver of geographical land price variation (Livanis et al. 2006). For example, higher competitive pressure from urban land demand implies a higher elasticity of land supply faced by farmers in proximity to urban areas (because of more opportunities for landowner arbitrage between farm and urban uses of land) relative to more distant locations, where land has fewer alternative uses outside farming. The capitalization of land subsidies is expected to rise with the proximity of farmland to urban centers.

Overall, the theoretical literature does not examine the extent to which these and other drivers affect subsidy capitalization. Another critical unanswered question is whether spatially differentiated capitalization levels across heterogeneous locations converge to the predictions of the perfect competition model in the long run.

3. EMPIRICAL EVIDENCE

The empirical literature aims to establish a more precise and robust magnitude of the capitalization rates of different subsidies under various land-market setups and to explain the factors that determine it.

Most empirical studies have found that subsidies increase land rents and land values and that the capitalization rate lies between 0% and 100%, with significant variation across studies. The vast majority of the studies cover the US (50%) or the EU (46%) (Baldoni et al. 2021). Of the 719

¹⁵ The distance costs act as a measure of competitiveness for the rental market. With the increasing importance of space, the competitiveness of the market decreases, and eventually farms may have local monopsony power.

estimates (60% for land rents and 40% for land values)¹⁶ identified in the recent literature, around 62% found a statistically significant positive value, while around 6% found significant negative values. The remaining 32% of the literature estimates are statistically insignificant. The share of positive and significant estimates is higher in studies on land rents (around 74%) compared to those found in the studies on land values (45%). More than 90% of the positive and significant capitalization estimates lie between 0% and 100% across all studies. These patterns are largely consistent across US and EU studies with the exception of studies on land values where significantly more estimates are statistically insignificant in the EU studies (73%) than US (28%) studies as well as the share of positive and significant capitalization estimates between 0% and 100% is greater in US studies (94%) than EU studies (77%) (Table 1).

The average capitalization rate across all estimates and subsidy types is 33% for land rents and 12% for land values.¹⁷ On average, the estimates for rents are greater for the US (42%) than the EU (26%), while for land values, they tend to be more alike (14% and 9%, respectively) even though their variation is significantly greater for the EU than the US (82% and 37% of standard deviation, respectively) (Table 2). These results suggest that the capitalization rate estimated in the empirical studies is more consistent with the recent theoretical literature, which predicts lower capitalization than the early perfect-competition literature did.

The average capitalization rate estimates vary over time although the pattern is different for rents and land values. Figure 1 shows the distributions of capitalization rates over time given by the dates of publication for the full sample and separately for the EU and the US. The average estimate of the capitalization rate using land rents decreases over time. While the variation of those estimates seems consistent in the full and EU samples, the estimates for the US appear to converge over time (panel (a) of Figure 1). Using land values, we observe less pronounced changes in the average capitalization rate over time. However, the variation tends to increase (panel (b) of Figure 1). The causes of the temporal differences in the capitalization rates could be changes in subsidy types and the evolution of the econometric techniques applied to estimate the relationship. This inter-temporal variation in estimates is confirmed to be the case in Baldoni et al.'s (2021) meta-analysis of capitalization studies.¹⁸

The empirical literature seems less conclusive than the theoretical literature about the specific capitalization rates of different subsidy types, although some patterns are detectable. On average, consistent with the theoretical prediction, decoupled payments tend to be capitalized more into land prices than coupled or environmental payments. The average capitalization rate into land rents (values) is 37% (25%) for decoupled payments, 24% (5%) for coupled subsidies, and 2% (-26%) for environmental payments. Similarly, land-based subsidies tend to be capitalized

¹⁶ We focus on the studies estimating capitalization rates, which is the most commonly estimated parameter in the empirical literature and has a more meaningful economic and policy-relevant interpretation. Studies estimating capitalization elasticities are more common for land values; a review, including meta-analyses, is provided in Feichtinger and Salhofer (2013).

¹⁷ We have applied the NPV model to convert estimated capitalization coefficients for land values to annualized capitalization rates, which are comparable with estimated rates for land rents. The discount rate used to convert estimates into capitalization rates is the average US government bond yield between 2010 and 2019 and equals 2.4%.

¹⁸ Baldoni et al. (2021) conducted meta-regression for both rents and land values to account for different factors affecting the estimated capitalization levels in the literature.

more into land prices (35% for rents and 17% for land values) than non-land-based subsidies (20% and -1%) (Table 2). This pattern seems stronger for land rents than land values and for coupled vs. decoupled subsidies, though the estimates vary substantially across studies. Baldoni et al. (2021) largely confirm these results in their meta-analyses. Even for specific subsidies, such as the SPS/SAPS in the EU and the Production Flexibility Contracts (PFCs)¹⁹ in the US – which are most commonly investigated in the recent empirical literature – the capitalization estimates have a relatively high variation (standard deviation) across studies (Table 2).²⁰ As discussed in the theory section, in the case of the SPS/SAPS, the rather high variation of the capitalization rate estimates could be plausible because their implementation vary significantly between the studied EU countries (Guyomard et al. 2004, Kilian and Salhofer 2008, Ciaian et al. 2008, 2014).

Most empirical studies are based on reduced-form models without any structural link to an underlying theoretical framework. Instead, they typically attempt to provide some reasoning (explanation) for the estimated discrepancy with respect to theoretical models or previous empirical studies without empirically testing it. The most common explanations are land-market institutions and market imperfections. Other studies have found heterogeneous capitalization effects across different observation dimensions (e.g., farm size, lengths of tenancy, and market concentration), potentially indirectly capturing heterogeneity in drivers related to the local market power or land-market institutions. For example, Kirwan (2009) estimated that the capitalization rate of agricultural subsidies in the US decreased with the rental market concentration (measured by the Herfindahl index). Similarly, Kirwan and Roberts (2016) found that the subsidy capitalization rate falls by about 1.2 cents for every year of a rental contract's duration. Kilian et al. (2012), Michalek et al. (2014), and Baldoni and Ciaian (2021) estimated how different implementation aspects of the EU's SPS (e.g., payment heterogeneity, scarcity/surplus of entitlements) reduced or increased the capitalization rate.

Overall, the variance of econometric estimates across empirical studies is wide, although it has decreased over the last two decades. This is reflected both in the relatively high standard deviation of the estimated capitalization rates across studies²¹ and in extreme values – several studies imply capitalization rates significantly smaller than 0% or significantly greater than 100% (Figure 1, Table 1, Table 2). On the one hand, as reviewed in the theoretical section, this cross-study variance in capitalization estimates has objective reasons (including negative and/or greater than 100% capitalization rates), such as differences in the studied subsidy types, subsidy implementation details or the presence of market imperfections; on the other, several econometric estimation and data issues pose challenges to identifying the true magnitude of the subsidy capitalization into land prices, which may lead to unreasonable (or extreme) estimates.

In general, data availability drives most empirical strategies (e.g., regions covered, types of subsidies, time periods considered, and control variables used), typically relying on existing data from official sources that are not necessarily collected to study the capitalization effect but for

¹⁹ These are also referred to as AMTA payments.

²⁰ The exception is the capitalization of PFCs into land values.

²¹ For example, the standard deviation is often greater than the average capitalization rate for different subsidy types reported in Table 2.

other reasons (e.g., the Farm Accountancy Data Network [FADN] in the case of the EU and the Agricultural Market Transaction Act [AMTA] in the case of the US). As a result, the data may not contain important control variables (e.g., land rental arrangement details), potentially biasing estimates and limiting the validity of econometric approaches.

Regarding the econometric issues, a common identification challenge of the empirical literature is related to the three main sources of bias: various types of measurement errors and omitted-variable bias. More recently, the role of spatial effects has been stressed in the context of rural land markets. The meta-analyses of Baldoni et al. (2021) and Salhofer (2013) confirmed that the choice of estimation methodology (including the type of data used) significantly affect the estimated capitalization effects.²² We discuss these estimation and other issues in more detail in the next section.

4. PROBLEMS WITH EMPIRICAL ESTIMATIONS²³

4.1. Data-Generating Process

The sample selection bias and the data type and their structure may all impact estimated capitalization effects. *Sample selection bias* may arise because the probability of observing a particular observation (e.g., renting farms) in a sample may be non-random and determined by the variables that also explain the farmland price. For example, such a correlation could be present between the rental choice and the productivity and payment levels or could be a result of the sampling strategy applied (e.g., excluding small or non-commercial farms in the FADN or over/under-sampling certain farm types in the ARMS). The results of Baldoni et al.'s (2021) meta-analyses of land rents indicate that studies that do not consider selection bias overestimate subsidy capitalization rates and those that use FADN or ARMS data tend to underestimate them. The approach often used in the literature to address this problem is applying an estimation approach that controls for selection bias (e.g., Kirwan 2009, Ciaian and Kancs 2012, Michalek et al. 2014, Guastella et al. 2018).

The *type and structure of the available data* also have important implications for the ability to correctly identify the true capitalization rate. Due to confounding general equilibrium effects, the capitalization estimates based on farm-level data are expected to be biased downwards compared to those based on regional data or to capture other non-subsidy-related effects not controlled for in estimations (e.g., regional effects). Feichtinger and Salhofer's (2013) meta-analyses indicate these identification challenges, finding that the capitalization elasticities of land values are generally higher in studies using aggregated data than in those based on farm-level data. In contrast, the meta-analyses of Baldoni et al. (2021) showed that the estimated capitalization rates into land rents are higher in the studies using micro-data than those using other data types.

²² The difference between the two meta-analyses is that Feichtinger and Salhofer (2013) considered the capitalization elasticities of subsidies into land values, whereas Baldoni et al. (2021) covered more recent studies and considered the capitalization levels (instead of elasticities) of subsidies in both land rents and land values.

²³ For more details, see Baldoni et al. (2021).

4.2. Measurement Errors

Measurement errors may arise because of attenuation bias, measurement error in the expected subsidy measure, or measurement error in the dependent variable. *Attenuation bias* is a form of measurement error that arises because the actual subsidies are observed, but land prices are determined by (unobservable) expectations about uncertain future subsidies, which may bias the capitalization rates downwards (Alston and James 2002, Goodwin et al. 2011). As shown in Baldoni et al.'s (2021) meta-analyses, empirical studies that do not address the expectation error tend to have lower estimates than studies that do address it. The approaches applied in the literature to overcome the expectation error bias attempt to capture farms' expectations directly, adjust the realized variable by estimating it from some other external source, or apply instrumental variables (Kirwan and Roberts 2016, Goodwin et al. 2011, Kilian et al. 2012, O'Neill and Hanrahan 2016).

Subsidies are usually elicited at the farm level, while land prices are often set at the field level, which may result in a *measurement error in the expected subsidy measure*. This may cause the variance of the observed farm-level subsidy rate to be lower than the variance of field-level land prices, biasing the estimated capitalization rate upward. The approaches applied to circumvent the measurement error in the expected subsidy measure are to use disaggregated data at the level at which land-market transactions take place (e.g., the field level) or to use valid instrumental variables (e.g., Kirwan and Roberts 2016).

Often, the available data do not contain full information on rental agreements or sale transactions, potentially resulting in *measurement error in the dependent variable*, which may bias estimates when the measurement error is correlated with independent variables, forcing econometricians to construct proxies for the dependent variable from the observed data (Kirwan 2009, Hendricks et al. 2012). To avoid measurement error in the dependent variable and consequent bias, data that contain more detailed information on land transactions are desirable to be applied (e.g., field-level cash rental rates, as in Kirwan and Roberts 2016).

4.3. Omitted-Variable Bias

Estimated capitalization rates are often subject to bias because of variables omitted by price inertia and productivity heterogeneity. As discussed in the theoretical section, land-market institutions may generate *price inertia* in land markets that, if unaccounted for, may produce significant differences between the short-run and long-run capitalization of agricultural subsidies. Baldoni et al.'s (2021) meta-analyses showed that studies using dynamic specification tended to estimate lower (higher) short-run or long-run capitalization rates of subsidies in land rents (values) than studies with other model specifications. Similarly, Feichtiger and Salhofer's (2013) meta-analyses showed that the inclusion of lagged variables reduced estimates of capitalization elasticities.

The ideal approach to addressing this source of the omitted-variable bias is to use data that allow controlling for factors that cause land-market inertia (e.g., data on rental contract arrangements, land regulations, and social norms). For example, to circumvent this source of

omitted-variable bias in land rents, Patton et al. (2008) used unique panel data for Northern Ireland, where rental rates are set annually. Similarly, Kilian et al. (2012) used information on newly signed rental contracts to better identify the capitalization effect of SPS in Bavaria (Germany). Another common approach in the literature to address the inertia issue is to use instrumental variable estimators with panel data and estimate models with land-market dynamics (e.g., Hendricks et al. 2012, O'Neill and Hanrahan 2016, Baldoni and Ciaian 2021).

Another fundamental issue in the empirical literature on subsidy capitalization is the *heterogeneity* of farmland productivity, which is usually imperfectly observed in most data sets (Karlsson and Nielsson 2014). By design, most agricultural subsidies are not assigned randomly but depend on the underlying (historical) farmland's productivity (e.g., in the EU and the US). If this unobserved heterogeneity is correlated with explanatory variables, it biases the estimated capitalization coefficients upward due to omitted variables (Michalek et al. 2014, Kirwan and Roberts 2016, Baldoni et al. 2021).

Several recent capitalization studies have addressed the unobserved heterogeneity of land productivity with farm-fixed effects estimators or the system Generalized Method of Moments (GMM) estimator (Hendricks et al. 2012, Feichtinger and Salhofer 2016, O'Neill and Hanrahan 2016, Baldoni and Ciaian 2021). The underlying productivity can be accounted for in cross-section data (e.g., the ARMS survey, which does not have a panel structure), such as by including dummy variables (e.g., regional dummies) and/or productivity-related variables (e.g., soil quality) in the econometric specification (Kilian et al. 2012). Time-varying unobserved heterogeneity is more challenging to account for; as shown by Bonhomme and Manresa (2015), the grouped-fixed effect estimator could be used in such a situation because it allows controlling for time-varying unobserved heterogeneity modeled with distinct-grouped patterns.

4.4. Spatial Effects

A prominent approach in the recent capitalization literature attempts to account for spatial autocorrelation, spatial dependence, and spatial heterogeneity (e.g., Breustedt and Habermann 2011, Guastella et al. 2014, Karlsson and Nielsson 2014, Feichtinger and Salhofer 2016). *Spatial autocorrelation* and *spatial dependence* may occur because events and shocks taking place in neighboring locations influence the decisions of geographically proximate economic agents and thus may bias estimates if unaccounted for (Anselin 2001). The meta-analyses of Feichtinger and Salhofer (2013) showed that the estimated capitalization elasticity of subsidies in land values is higher when a spatial econometric model is estimated.

Whereas spatial autocorrelation is related to spatial interactions, *spatial heterogeneity*, which is a structural instability, relates to spatial structure. Taking the form of non-constant error variances in a regression model (heteroskedasticity) or variable regression coefficients, it is an inherent problem in land price analysis (Anselin 2001). According to Roberts et al. (2003), empirical studies that do not account for spatial heterogeneity tend to have higher estimates than other studies.

Despite the growing application of spatial econometrics, most empirical studies on subsidy capitalization into land prices have neglected the spatial structure of underlying farmland data. Karlsson and Nielsson (2014) proposed an approach to spatial heterogeneity by estimating a multilevel spatial model with hierarchically structured data. Another approach frequently applied in the empirical literature is to estimate different regions separately or have subsidy variables interact with regional dummies (e.g., Goodwin et al. 2003, Kirwan 2009).

5. CONCLUSIONS AND DISCUSSION

This paper reviews the main findings, developments, and gaps of the recent theoretical and empirical literature on the capitalization of agricultural subsidies into land prices. A rich literature has developed in this field primarily to understand the transfer efficiency of agricultural support. The main objective of this literature is determining whether subsidies benefit landowners – the group usually not targeted by agricultural policies – by increasing farmland prices. Subsidy capitalization is a particularly relevant issue for developed countries where the subsidization of the agricultural sector has a long history. Recently, agricultural subsidies have been introduced in many developing countries, making the capitalization issue increasingly relevant to them as well.

The theoretical literature predicts that, owing to an inelastic land supply, agricultural subsidies are largely capitalized into land prices when land markets are competitive and function relatively well. At the same time, the theoretical literature can accurately rank the various types of agricultural subsidies by their expected capitalization levels under the assumption of a competitive market environment and symmetric, aspatial agents. The most recent theoretical literature suggests that this result may change, however, when considering the implementation details of subsidies, formal and informal land-market institutions, market power, spatial effects (which may reduce the capitalization rate), incomplete rural markets (which may cause the capitalization under certain circumstances to be greater than 100%), and other idiosyncrasies.

Although analytical results are rather complex and capture the capitalization of alternative subsidy types and several aspects of their implementation mechanisms, the theoretical literature remains underdeveloped in several areas. This is particularly the case without the perfect-competition assumption, without the possibility of full, instant land-market adjustments (e.g., in the presence of formal and informal land-market institutions and market imperfections), and when considering spatial dependence and heterogeneity of land markets. These are key areas where the existing theoretical literature cannot provide an adequate account of subsidy capitalization. Building on the few attempts already present in the field, these are promising avenues for future research.

Most empirical studies have confirmed that subsidies increase land prices. However, the empirical evidence rejects that subsidies (including land-based ones) are primarily capitalized into land prices, meaning that landowners primarily benefit from them. The capitalization rate is higher than zero but significantly less than 100%, although there is a significant variation across studies. Ultimately, the relatively low estimated capitalization rate in the literature suggests that at least a portion of subsidies likely remain with the intended policy recipients, that is, farmers.

The empirical literature cannot fully explain why the estimations vary considerably across studies and is inconclusive about the specific capitalization rates of different subsidy types. Although studies tend to show that decoupled payments and land-based subsidies have higher capitalization rates than coupled payments and non-land-based subsidies, respectively, the estimated capitalization rates vary widely. The main reasons for this variation are data quality and econometric issues: expectation error, measurement error, omitted-variables bias, spatial autocorrelation, and spatial heterogeneity. Despite these issues, econometric techniques are continuously improving, and capitalization estimates are becoming more robust.

Following these analyses, the following is a valid follow-up question: What are the most acute areas with the most value added for future research? Eventually, one of the most policy-relevant areas is to improve the understanding of the capitalization of new subsidies introduced in different countries, as they are increasingly complex and conditional on fulfilling different requirements, not necessarily targeting only farmers' income. Another important research focus is a better understanding of how land regulations interact with subsidies and affect their capitalization rate. In general, land regulations presumably reduce subsidy capitalization, but limited theoretical or empirical evidence exists for specific mechanisms or channels that affect land prices. From a policy perspective, this effect is desirable because it reduces the leakage of subsidies away from the farming sector, but it can have other unintended effects. Thus, a better understanding of which land regulations affect the capitalization of subsidies would help answer the policy-relevant question of whether farmland regulations have unintended side effects by altering transfer efficiency.

Market imperfections and informal institutions are also promising areas for future research, as they may reduce subsidy capitalization, while incomplete rural markets may act in the opposite direction. Again, these issues are not well studied or understood in the existing literature.

The focus of the existing literature is on developed countries. However, agricultural subsidization is rising in many developing countries where rural market imperfections are more pervasive and have far-reaching implications for the functioning of land markets. A better understanding from both theoretical and empirical points of view is desirable to see if policy leakages are important in these countries and whether the subsidy capitalization effects are comparable to those in developed countries.

To make it possible to address these –unanswered policy questions related to subsidy capitalization – there is a growing need for capitalization-targeted survey data that would allow identifying capitalization effects and control for factors that affect it, such as the implementation details of subsidies, land-market institutions and rural market imperfections, spatial effects, and others. So far, most empirical estimates use existing (official) data, which are usually not collected to study subsidy capitalization but for other reasons that fundamentally restrict the possibility of using them to identify capitalization effects accurately. One possible solution to attenuate the data problem is extending the existing data by collecting additional variables necessary to study capitalization effects. Another more demanding solution is developing surveys to identify true capitalization effects.

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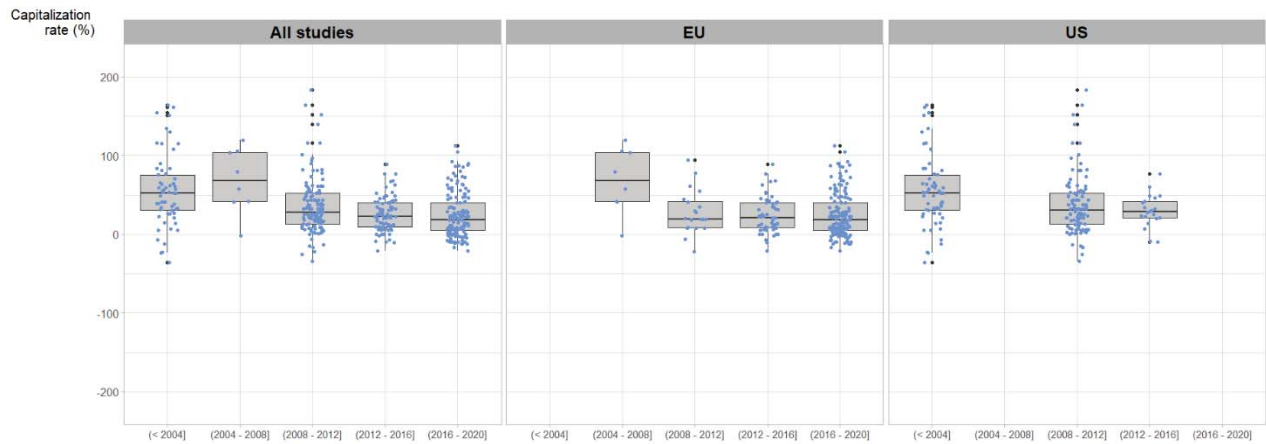
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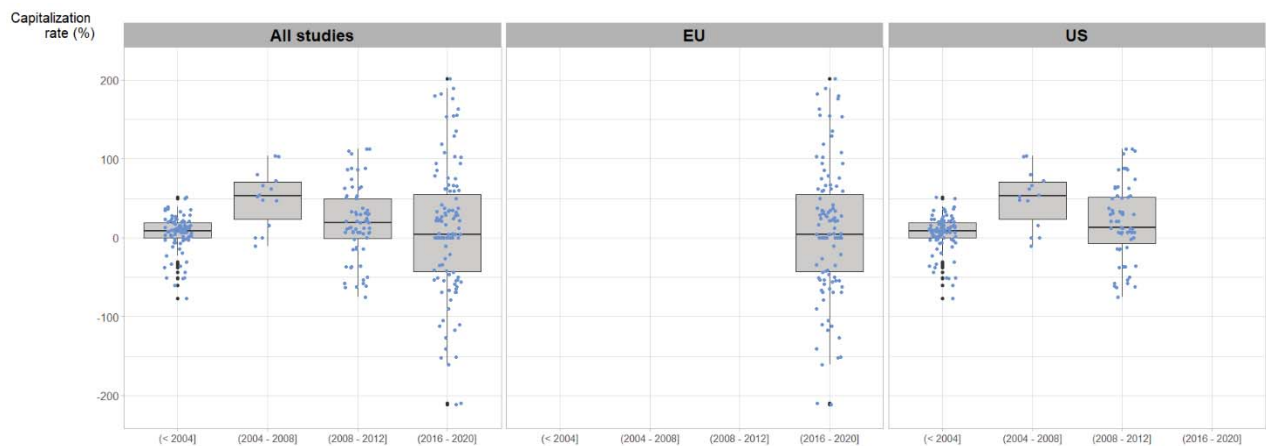
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Figure 1. Capitalization rate estimates in the literature by date of publication

a) Land rents



b) Land values



Notes: The figures show average capitalization rates and standard deviations around the average value for different publication dates of empirical studies. The capitalization rates in panel (b) are calculated following the NPV model by dividing the estimated capitalization level on land values by the present value of subsidies. The discount rate used to convert estimates into capitalization rates is the average US government bond yield between 2010 and 2019: 2.4%. If the rate is equal to 100% (less than 100%), it implies full (partial) capitalization of subsidies in land values. A value smaller (greater) than 0% (100%) implies negative (greater than full) capitalization of subsidies into land values.

Source: Elaborated by authors based on a review of empirical capitalization studies. For more details, see Baldoni et al. (2021).

Table 1. Frequency table of capitalization estimates by geographical area

Frequency of results across studies	All studies (%)	Studies on land rents (%)			Studies on land values (%)		
		All	US	EU	All	US	EU
Significant positive capitalization effects	62.59	74.13	78.53	70.66	45.10	59.28	22.61
<i>of which</i>							
<i>Capitalization rates between 0% and 100%</i>	93.56	94.70	91.33	97.66	90.70	93.94	76.92
<i>Capitalization rates greater than 100%</i>	6.44	5.30	8.67	2.34	9.30	6.06	23.08
Significant negative capitalization effects	5.56	3.00	2.62	3.31	9.44	13.17	4.35
Insignificant capitalization effects	31.84	22.86	18.85	26.03	45.45	27.55	73.04

Notes: Column totals sum up to 100% as well as column sub-totals for the distribution of studies with “*significant positive capitalization effects*”.

Source: Elaborated by authors based on a review of 719 empirical capitalization estimates in the literature. For more details, see Baldoni et al. (2021).

Table 2. Average estimated capitalization rates across studies

Subsidy type	Capitalization rate in land rents				Capitalization rate in land values			
	No observations	Average (%)	Std. dev. (%)		No observations	Average (%)	Std. dev. (%)	
All studies	433	33.00	34.59		286	12.28	59.05	
<i>Geographic area</i>								
US studies	191	42.07	39.40		167	14.26	37.34	
EU studies	242	25.84	28.36		115	9.19	81.67	
<i>Subsidy types</i>								
Coupled payments	48	23.53	38.15		47	5.35	24.91	
Decoupled payments	221	37.40	32.38		97	24.94	80.59	
Environmental payments	29	2.04	12.25		29	-25.68	38.18	
Other payments	135	35.82	36.26		113	14.03	46.39	
<i>Subsidy target</i>								
Land-based payments	234	35.37	32.67		120	17.39	75.49	
Non-Land-based payments	56	20.16	36.24		53	-0.64	28.95	
Mixed payments	143	34.14	36.12		113	12.9	48.19	
<i>Specific subsidies</i>								
SPS/SPS (EU)	109	29.19	19.27		56	20.48	95.65	
PFC (US)	46	65.58	40.23		15	14.08	10.11	

Source: Elaborated by authors based on a review of 719 empirical capitalization estimates in the literature. For more details, see Baldoni et al. (2021).