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Bundling and splitting: workspace tenure in two vectors

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ABSTRACT
The Bundling and Splitting Matrix is a conceptual framework of real property tenure. It is used here to derive hypotheses as to the effects of two principal-agent problems: adverse selection and moral hazard on commercial office workspace energy performance under differing tenure types. The purpose of testing these hypotheses, in future research, is to inform disclosure policy. Disclosure here refers to the sharing of information between commercial office workspace lessors and lessees. In demonstrating this framework's use, this paper's contribution is methodological. Mitigating adverse selection is the objective of international ex-ante disclosure programs but past research has not isolated ex-ante disclosure's effect in that mitigation from its other effects. The use of this framework also extends the method used by research measuring energy performance under different contract types. By putting tenure type, rather than a single contract as the object of inquiry, it sets out single or multiple possibly additive or counter-veiling principal-agent problems, adverse selection and moral hazard, each with its disclosure remedy. It is argued that doing so is increasingly significant with the growth in information age forms of workspace tenure such as coworking.

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Introduction

One way to reduce carbon emissions is by improving the energy efficiency of commercial office buildings (Hong et al. 2015). Energy efficiency is defined as *"using less energy to provide the same service"* (Lawrence Berkeley, 2017).

Economic principal-agent theory describes how differing incentives and access to information can create problems (Eisenhardt, 1989). These "split incentives" can lead to investment in energy efficiency at lower than pareto-optimal levels (Economidou 2014). Theoretically, the first-best remedy for such energy efficiency market-failure is information (Allcott & Greenstone, 2012) in our case, "disclosed" between the lessor and lessee of commercial office workspace. This disclosure can be either ex-ante or ex-post to the commercial office lease contract being agreed upon.

A specific objective of Australia's mandatory ex-ante commercial building disclosure program is to mitigate the principal-agent problem of adverse selection (Acil Allen, 2015). Empirical research, including that by Fuerst, Gabrieli, and McAllister (2017)

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and Das and Wiley (2014) observed that ex-ante disclosure has other effects beyond such mitigation. In the context of mandatory ex-ante disclosure, there is the need for a method that endeavours to isolate the problem that disclosure aims to mitigate.

Moral hazard is a second principal-agent problem theoretically mitigated by disclosure ex-post. Jessoe, Papineau, and Rapson (2019) identified moral hazard and find net contracts preferable to gross. The method used in that research is to compare energy performance under different contract types. It does not account for the energy performance of workspaces whose tenure involves multiple contracts, each susceptible to possibly different principal-agent problems and their disclosure remedies.

This raises two questions this paper will address: How can single or multiple, principal-agent problems be identified and their effect upon the energy performance of commercial office workspaces be assessed? What does this mean for disclosure policy?

The paper starts with an overview of principal-agent theory and the methods used by empirical research that has applied the theory to lessors and lessees. Following is a description of the conceptual framework, the Bundling and Splitting Matrix and how it enables identification of multiple and single principal agent problems. Using the Australian CBD (2015) measure of energy efficiency: the National Australian Built Environment Rating System (NABERS), the framework's use is then demonstrated to derive three hypotheses. The analysis section discusses the significance of testing these hypotheses, and in the conclusion section, policy implications.

Theoretical background

Adverse selection and moral hazard are two principal-agent problems created by differing incentives and access to information. Distinguishing between the two is important because each has a different disclosure remedy.

Adverse selection

Molho (1997) describes the principal-agent problem of adverse selection as one of pre-contractual opportunism. Applied to the lessee and lessors of commercial office workspace, this problem occurs if a prospective lessee suffers information asymmetry as to the energy efficiency of a base-building accommodating a tenancy offered under a contract net of energy utilities. Unable to distinguish an above average energy efficient workspace from a below average one, a sufficiently sceptical prospective lessee is assumed to be willing to pay no more than average for the energy efficiency component of the workspace costs. In turn, this removes any incentive for the net lessor to bring the base-building's energy efficiency above average. And if this is game is repeated, and many lessors similarly underinvest in energy efficiency, then the average energy efficiency of the base-buildings deteriorates, until the market becomes filled with what Akerlof (1970), with reference to a similar process in the used car market, describes as "a market of lemons." Removing this information asymmetry through the disclosure of energy performance information, theoretically, arrests the downward moving mean energy efficiency.

In Australia, almost all commercial office leases (PCA, 2015) are net of both base-building and tenancy energy utilities. The lessee pays for tenancy energy, that is lighting, tenancy package heating ventilation and air-conditioning (HVAC), plug-loads, etc., direct to the energy utilities company. The lessee also pays for their pro-rated share of base-building energy, that is energy used to power the central building services, HVAC, vertical transportation, security, common area lighting and power, etc., "passed-through" with the rent bill.

The mandatory Australian Building Energy Disclosure Act (2010) requires a commercial building with a workspace greater than 1000 square meters of net lettable area (NLA) to disclose a base-building National Australian Built Environment Rating System (NABERS) energy efficiency star-rating, or a whole-building NABERS rating (if the tenancy is not separately metered) whenever a commercial office workspace or building or of 1000 square meters or more is offered to the market for sale or lease or sublease. These NABERS star-ratings increase from 0.5 to 6.5 stars in 0.5 star increments (NABERS, 2019).

Acil Allen (2015) describe one aim of the NABERS program being to mitigate adverse selection. In their review of the CBD program, 4 years after it started, they found a marked increase in building energy efficiency as measured by assessed NABERS ratings, particularly among the highest quartile of energy rated buildings. The report did not identify what share of this increase in NABERS ratings was attributable to the mitigation of adverse selection, and how much any other financial benefits of disclosure. These other benefits presumably include the perceived value the disclosure of a base-building's energy efficiency rating will add to a company's brand, and what Das and Wiley (2014) call "expected marketing benefits."

Research measuring the effect of international disclosure rating programs, using a different method, suffers a similar limitation. Controlling hedonically for building attributes, building energy efficiency, or eco-certification ratings are regressed with sales and rental premia. These premia are the extra amount paid by the purchasers of a building (sales premia), or by lessors of a tenancy workspace (rental premia), over and above that paid for an unrated building or workspace control group.

Using this method, premia have been found by Miller, Spivey, and Florance (2008), Eichholtz, Kok, and Quigley (2010), Kahn and Kok (2014) and many others. Rental premia have generally been found to be lower than sales premia, and by Gabe and Rehm (2014) to be negligible. While for Oyedokun (2017) some of this research, suffers from an insufficient sample size, it is accepted here that ex-ante disclosure creates sales premia but lesser or negligible rental premia, and has effects other than those attributable to it as signal of future energy costs.

Once it is accepted that disclosure has other effects, then it is also possible that the entire source of the premia is due to these other factors. This was explored by Fuerst, Van de Wetering, and Wyatt (2013) who do find rental premia, but mainly for the newer high-grade buildings in their sample. Szumilo and Fuerst (2014) find a positive relationship between rating level and energy costs, contrasting with a theoretically anticipated negative relationship, to conclude that lessees are willing to pay more for workspace in highly rated buildings, but are not doing so to reap energy cost savings.

One explanation of this finding is that there is an absence of the problem that ex-ante disclosure aims to mitigate. This conjecture was made by Gabe and Rehm (2014) upon their finding of no rental premia. If true it would presents an empirical challenge to

Akerlof's (1970) theory It is given weight by Jin, Luca, and Martin (2015), who find that consumers are not sufficiently sceptical about undisclosed information.

For the deterioration of average energy efficiency leading to Akerlof's (1970) market of lemons, a prospective lessee must presume the worst, and that the undisclosed information about the energy efficiency of workspace is a signal of lower than average energy performance. An un-sceptical prospective lessee would not necessarily pay a less than average price, the average base-building energy efficiency in the market would not deteriorate, no market of lemons would result, and there would be no problem for ex-ante disclosure to mitigate.

To measure the effects of ex-ante disclosure upon mitigating adverse selection requires a method that identifies the split incentives problem that international ex-ante disclosure policies seek to mitigate.

Moral hazard

Molho (1997) describes a second principal-agent problem of moral hazard as stemming from post-contractual opportunism. It occurs in the reverse situation of that associated with adverse selection: when the agent, suffers information asymmetry with respect to a principal. It precludes the pareto-optimal sharing of risk (Hölmstrom, 1979; Stiglitz, 1975).

Moral hazard has been found empirically by Jessoe et al. (2019). Lessees under contracts net with energy utilities consume up to 14% less energy than those under contracts gross with utilities.

Stiglitz's (1975) theoretical solution to moral hazard is for the agent to screen the behaviour of the principal ex-ante. Although this level of oppressive surveillance may soon be possible via the "internet-of-things," at the time of writing it is neither practical nor possible for a prospective commercial office workspace lessor to screen a range of prospective lessee's energy using habits. Hölmstrom (1979) provides a contract-based solution. Clauses can be written into the contract, ex-ante, that alter risk-sharing based upon observed behaviour ex-post, that is during the lease. Hart (1995) observes that there are incentives for both parties to agree to ex-post observation and monitoring so that neither party carries too much risk. Fudenberg and Tirole (1990) go further to advocate a contract with a menu of options depending upon observed actions.

Rather than improving energy performance being a matter of a choice between contracts, it becomes a matter of optimisation. Whitson.'s (2011) Model Green Lease provides an example of this remedy. It is essentially a gross contract, where the lessor pays for energy, but only up until energy consumption reaches an expense stop, after which the lease reverts from gross to net, and the lessee starts to pay. Gandhi and Brager (2016) identify a similar solution: writing an energy budget into a lease agreement with overage penalty.

Workspace energy efficiency may be affected by more than one contract and in the following section, it is argued this is increasingly likely in the information age.

Tenure in two vectors

The word tenure is derived from the French verb "tenir" which means to hold. It is defined as *"the act, right, manner, or term of holding something, such as a landed property or a position"* (Merriam Webster Dictionary, 2017).

In Australia and other commonwealth countries and former British colonies, almost all land is held under Crown Title. Two key aspects of Crown Title are that landowners can hold a portion of the crown land freehold, and that an apportioned part of it can be described and subdivided in terms of space, and then be "alienated" to lessees through a process of "subinfeudeation" (Sackville, Neave, Edgeworth, Rossiter, & Stone, 2008).

Information and communications technologies have decreased the cost of managing this subinfeudeation. The cost of managing commercial office workspaces in increments of space and time has approached the cost of managing them whole and the cost of offering those increments across the boundaries of the firm, has, theoretically, approached the cost of undertaking activities within the firm (Bates, 1988; Godfrey, 2016). With each additional intermediary, with each "splitting," there is another principal and another agent, and the possibility of an additional principal-agent problem.

These technologies have another effect: they reduce the cost of "bundling" with information (Adams & Yellen, 1976), and of a workspace with material and information goods, human services, and the energy required for its operation (Godfrey, 2016). An offering bundled gross with energy is susceptible to moral hazard.

Coworking

Coworking tenure has a high degree of both bundling and splitting. Coworking commenced in 2005 in San Francisco (Leclercq-Vandelannoitte & Isaac, 2016) and by 2018 there were 19,000 coworking spaces worldwide, 29% of which had opened during that year (Lévai, 2018).

From the demand side, coworking engenders a community-driven environment (Weijs-Perrée, Appel-Meulenbroek, de Vries, & Romme, 2016). From the supply side (taken by this paper), coworking is a bundle of material and information goods and human services, offered gross with the energy, for periods of time as short as months, weeks, days, hours or even minutes (Godfrey, 2016).

Coworking involves an intensive use of space (Antoniades, Halvitigala, & Eves, 2018). While there is a positive correlation between occupancy intensity and energy consumption (Kim & Srebric, 2017) an increase in occupancy does not necessarily mean a decrease in energy efficiency. This is because energy efficiency is reducing consumption while maintaining the level of service provided (Lawrence Berkeley, 2017) so occupancy rates are controlled for in ratings such as NABERS. Intensifying accommodation does not decrease energy efficiency so long as the energy demands of the building mechanical services, notably heating ventilation and air-conditioning (HVAC) respond proportionately.

The coworking bundle commonly includes internet, Wi-Fi, specific web-content, software, other specialist equipment (Bouncken & Reuschl, 2018) and the provision of lounge areas, cafes or bars, to provide a basis for interaction between the coworking-users (Spinuzzi, 2012). With regards to energy performance, coworking involves "plug-loads".

Plug-loads are that portion of energy drawn through an electrical outlet. Tenancy plug-loads exclude large appliances, base-building or tenancy lighting, and central building systems such as HVAC, water heating and cooling (Sarfraz & Bach, 2018). Plug-loads are highly correlated with occupancy rates (Kim & Srebric, 2017) and so their relative importance increases when base-buildings become more energy efficient. They draw energy both directly and indirectly, because the heat they create also adds cooling load to the HVAC system. This extra, indirect load is up to 1.5 times that of the original plug-load (CIBSE, 2004).

The coworking lessor lacks the incentive to mitigate this moral hazard because it can pass increase in the rent or coworking membership fee to cover costs.

If the coworking lessor is a building owner, then this overconsumption might be the only principal-agent problem to contend with. If however, also a net lessee, then the energy of the workspace is affected both by this overconsumption of discretionary tenancy energy by the coworking lessee, and the underinvestment leading to adverse selection by the net lessor. This likely the case in Australia where the majority Australia's 116,955m2 of coworking space lessors were themselves, lessees of traditional space (Antoniades et al., 2018).

There is a gap in past research for a method that puts tenure type, rather than a single contract as the object inquiry. There is a need to account for energy performance under single or multiple contracts, each susceptible to possibly different principal-agent problems and their different disclosure remedies.

The bundling and splitting matrix

The Bundling and Splitting Matrix has two vectors. The bundling vector describes what is on offer, that is the workspace, and what is added to it. Bundling can be with any material or information good and human services. For our purposes the bundling vector increases from "N" net of energy, "B" gross with base-building energy, or "BT" gross with base-building and tenancy energy. The splitting vector refers to the division and subdivision of the freehold title into increments of space and time. The offering can be the whole building in perpetuity, a workspace tenancy on a long-term lease, or the use of a desk within a workspace for a matter of minutes. For our purposes, the splitting vector decreases from being owner occupied "O", a portion leased "L" for period of time, or "S" subleased. The two vectors intersect at each cell on matrix representing a tenure type. N,O net owned and bundled net of energy, N,L: bundled net of energy and leased. BT,SL bundled with tenancy energy and subleased, etc.

Data

The matrix can be populated with sample mean energy efficiency ratings within a jurisdiction mandating ex-ante disclosure. To demonstrate the use of the matrix this paper populates it with Australian CBD program NABERS ratings. Under the CBD program base-building and whole building ratings are mandatory, and calculated by a full assessment, but tenancy ratings not. For consistency, all energy efficiency ratings would be estimated using the calculator on the NABERS (2017) website. This requires accepting Hsu's (2014) finding that estimated building energy efficiency ratings anticipate energy consumption in the following year as effectively as do fully assessed energy efficiency ratings.

Three different NABERS ratings: Tenancy, Base-building and a new measure "Tenure" NABERS would be calculated. Tenure NABERS is not part of the CBD program but is devised here to be used across all tenure types.

To calculate the NABERS ratings, the estimator requires:

z – The post code of the building to control for climatic region
h -The number of building occupants
$\Sigma wNLA$ – The sum of the net lettable area of all the tenancies in the building
$wNLA$ – the net lettable area of the workspace

Each of the three ratings also requires input of the following data:

(1) Tenancy NABERS (T) – based upon tenancy energy consumption (*te*)

te – annual tenancy energy within the tenancy workspace from plug-loads, tenancy lighting, tenancy HVAC package plants etc. Data source is the tenancy meter.

(2) Base building NABERS (B) – based upon base-building energy consumption (*be*)

be – annual energy consumed by base-building services: central HVAC plant, vertical transportation, security, building management systems, lighting and common area plug-loads, etc. Data source is the base-building meter.

(3) Tenure NABERS (TN) – based upon tenure energy consumption (*tne*)

tne – annual energy consumption by the tenancy plus its pro-rated share of base-building energy: $(wNLA/\Sigma wNLA)(be) + te$

The tenure NABERS of a building with only one tenancy, as is the case in owner-occupied buildings, is equivalent to a whole-building NABERS rating.

Assumptions

1. Both principal and agent are assumed to be rational and that this rationality manifests itself through acting selfishly with opportunism and with guile (Wright, Dunford, & Snell, 2001). The principal (in our case the lessee) is assumed to be indifferent to risk and the agent (in our case the lessor) is assumed to be risk averse (Donaldson, 1990).

2. The level of service provided by the building and workspace is fully controlled for in the NABERS calculator: NLA, climatic region and occupancy rates. Such an assumption has validity because commercial office buildings in Australia, like their international counterparts follow a, remarkably standard form.

4. Buildings within each tenure type are similarly distributed in terms their range of age and quality.

Hypotheses

H1. Null μTN N,O =μTN N,L or TN N,S

The mean Tenure NABERS ratings under net owned tenure is the same as that under net leased or net-subleased tenure. This is consistent adverse selection either being absent or with it being fully mitigated by the mandatory ex-ante disclosure of base-building ratings.

H1. Alternative μ TN N,L or μ TN N,S < μ TN N,O

The mean Tenure NABERS ratings under net leased or net-subleased tenure is less than those under net owned tenure. This is consistent with adverse selection being present and not fully mitigated by mandatory ex-ante disclosure.

H2. Null μT N,L =μ T BT,S

The mean of Tenancy NABERS ratings under net leased tenure is the same as that under gross subleased tenure. If confirmed, this is consistent with there being no morally hazardous overconsumption of discretionary (plug-load) tenancy energy.

H2. Alternative μT N,L >μ T BT,S

The mean of Tenancy NABERS ratings under net leased tenure is higher, than under subleased gross tenure. If confirmed, then this is consistent with morally hazardous overconsumption of discretionary (plug-load) tenancy energy

H3. Null

If H1 and H2 null are true and
μ TN O,N >μ(TN N,L + TN B,L + TN BT,L)
and/or
μ(TN N,L + TN B,L + TN BT,L)> μTN BT,S

The mean Tenure NABERS rating is highest under owned, net tenure and lowest under subleased with base-building and tenancy energy (coworking) tenure the least.

H3. Alternative

If H1 and H2 null are true and
μ TN O,N =μ(TN N,L + TN B,L + TN BT,L)
and/or
μ(TN N,L + TN B,L + TN BT,L) =μTN BT,S
There are additional factors unique to BT,S tenure that drive energy efficiency.

Analysis

A significant difference between the energy efficiency under net owned tenure energy efficiency and that under net leased or subleased tenure rejects H1's null hypothesis. This finding would be consistent with adverse selection, not being fully mitigated by the ex-ante disclosure of base-building ratings. It would suggest that the absence of rental premia found by Gabe and Rehm (2014) would not be due to the absence of a principal-agent problem but that exante disclosure is an imperfect signal of future energy costs.

A finding that rejects null H2, is consistent with there being morally hazard overconsumption of discretionary tenancy (plug-load) energy consumption under gross contracts. While this would confirm Jessoe et al.'s (2019) finding of moral hazard, does not enable a conclusion that gross contracts are preferable to net, given the latter's susceptibility to adverse selection.

If both H1 and H2 are true, and H3 null stands, this would be consistent with principal agent problems being additive. It would confirm that energy efficiency is more than a choice between contract types, but a matter of optimisation.

Conclusion and policy implications

The bundling and splitting matrix sets-out tenure types and their theoretical susceptibility to single, or multiple, principal-agent problems. The results of testing of the hypotheses derived through this framework would have implications for disclosure policy (Figure 1).

Finding H1. that information asymmetry leading to adverse selection had not been fully mitigated by ex-ante disclosure, would support the continuation of ex-ante disclosure policies and programs but highlight their limitations. These limitations might steer policy to non-market-based mechanisms such as taxing the carbon produced during building operations.

The ex-post disclosure policy implication of H2, a finding of moral hazard, is less unclear. Mandating ex-post disclosure also requires contracts to set expense stops at the "goldilocks" level, the point at which the gross contract reverts to net. If set too high, then the contract is predominantly a gross contract subject to morally hazardous overconsumption, and if too low it is predominantly a net contract subject to adverse selection. Additional complexity is added by the practicalities of separating profligate, morally hazardous, consumption, unrelated to work, from consumption that is a variable cost and so by definition increases with work output. A simpler policy solution might be, as information technology decreases metering costs, to mandate pay-as you go for gross contracts.

A finding that H3 alternative is false – that there are no factors unique to coworking space that drive energy efficiency, would be consistent principal-agent problems being additive. Policy implications of such a finding could extend to discouraging or taxing tenure types such as coworking because sharing economy might not be not caring when it comes to energy efficiency.

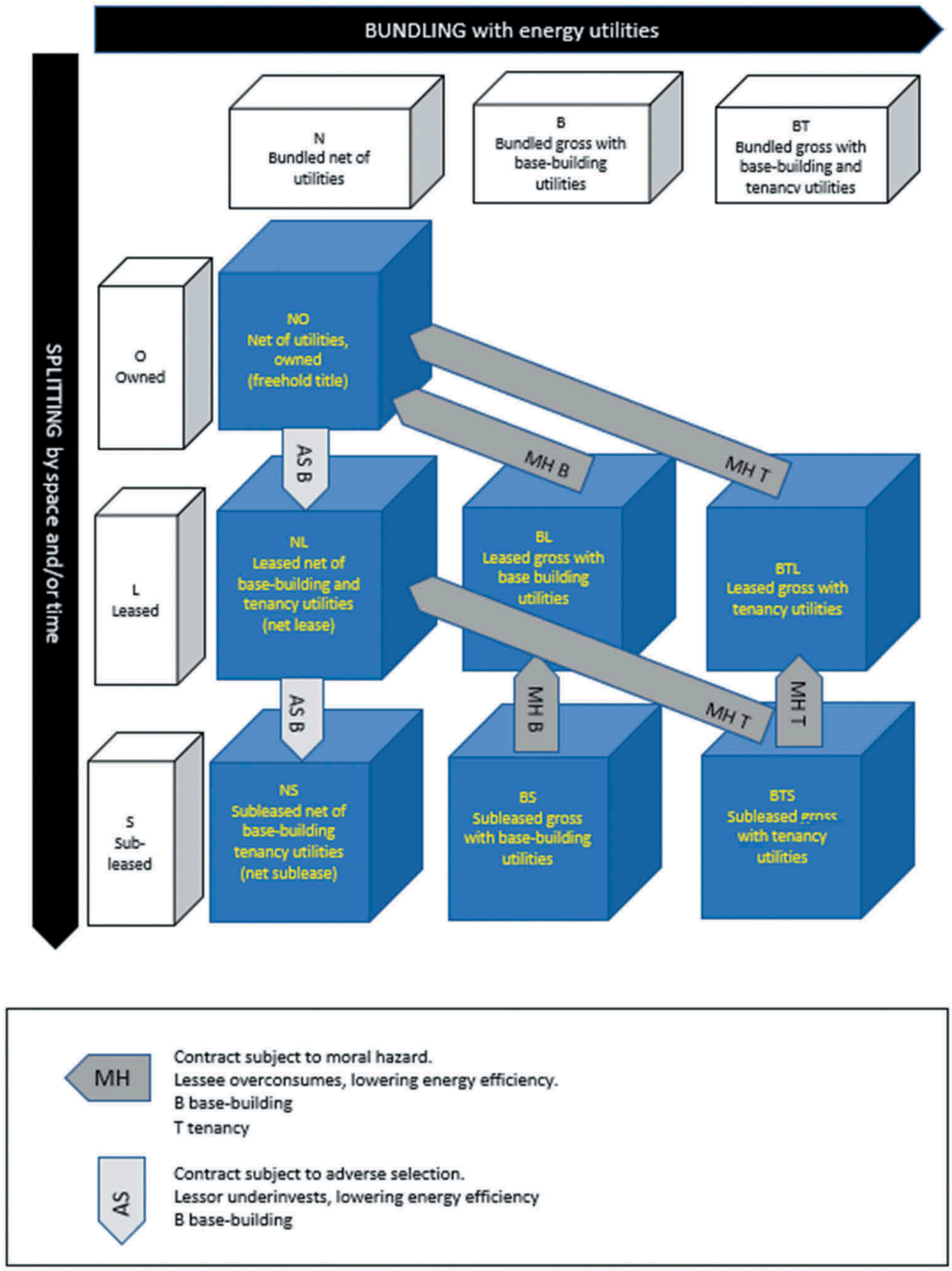

Figure 1. The bundling and splitting matrix with common tenure types.

Disclosure statement

No potential conflict of interest was reported by the author.

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