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"Lifestyle Leapfrogging" in Emerging Economies: Enabling Systemic Shifts to Sustainable Consumption

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Abstract:

This paper combines the concept of leapfrogging with systems-thinking approaches to outline the potentials for and barriers to enabling systemic shifts to strong sustainable consumption in the emerging economies of China and India. New urban consumers in China and India have the potential to “lifestyle leapfrog” the high impact lifestyle models of the industrialized countries while simultaneously improving their quality of life. This paper argues that by implementing systemic approaches in the consumption domains of mobility and housing, the historical trajectory of high environmental footprints of mobility and housing can be avoided. The analysis based on systems thinking principles identifies existing barriers and possible solutions. The importance of policies for strong sustainable consumption is highlighted to induce positive feedbacks in the areas of markets and society facilitating both efficient technology uptake and behavioral changes.

Key words: sustainable consumption, leapfrogging, systems thinking, India, China

1. Introduction:

It is now well–established that the consumption and production patterns of the industrialized world are environmentally unsustainable (Vitousek et al.,1997; Wackernagel et al., 2002; Wiedmann et al., 2006). As studies linking economic activity with climate change and biodiversity loss have shown, the consumption patterns of industrialized societies have significant environmental costs that threaten to jeopardize the ecological integrity of our planet, calling for new policy approaches to consumption challenges (UNEP 2012). This recognition has brought renewed attention to questions of consumption patterns and consumerism in the Western world, prompting numerous studies and initiatives that look to promote green consumption, voluntary simplicity, and sustainable local economies. At the same time, the boundaries of consumption systems between the industrialized countries and emerging economies are becoming increasingly blurred, especially as the lifestyles of urban consumers in India and China begin to look more like those of their Western counterparts (Lange & Meier, 2009; Myers & Kent, 2003).

While there is a small but significant movement calling for sustainable consumption in the United States, Europe and other developed countries, the question of sustainable consumption has not yet received systematic attention in emerging economies. Instead the development agendas of most emerging economies, in Asia in particular, emphasize the development of a robust domestic consumer market as a means of maintaining economic growth and stability. These visions of a growing consumer economy in India and China directly contradict the environmental reality: emerging economies cannot develop or consume in the same manner or to the same degree as the global north due to environmental change and resource constraints.

An acknowledgement of these environmental limits necessitates a serious reexamination of consumption trajectories in emerging economies by scholars and policy makers who can articulate alternate visions of lifestyles and identify pathways to change. It is in response to this need that we introduce the concept of "lifestyle leapfrogging." Lifestyle leapfrogging is a systems-based concept that explores and outlines how sustainable lifestyles of consumers in emerging economies could be realized from the outset, circumventing the unsustainable lifestyles of Western consumers. We draw on systems thinking methods, specifically Causal Loop Diagrams, to understand systemic drivers and barriers to lifestyle leapfrogging in the emerging

economies of China and India. We argue that such leapfrogging is both necessary and possible, and draw on a systems-based perspective of consumption practices to demonstrate how leapfrogging could be made possible through specific interventions in policy, markets and civil society. We use two case studies to develop the concept: : residential housing in China and mobility in India, chosen here because of the significant role these countries play in a global transition to sustainable systems of production and consumption.

The rest of the paper is organized as follows. In the next section, we briefly review the history of the concept of leapfrogging in its different avatars. We then extend it to the domain of consumption to introduce the concept of lifestyle leapfrogging and discuss it in relation to two different types of sustainable consumption: weak vs. strong sustainable consumption, where the former focuses on incremental shifts in consumption patterns that largely maintain the status quo while the latter emphasizes absolute reductions in consumption levels through resistance, downshifting and voluntary simplicity. In section 4, we turn to empirical evidence to show how some efforts at lifestyle leapfrogging for weak sustainable consumption are already underway in India and China. Section 5 shifts focus to strong sustainable consumption, and we utilize Causal Loop Diagrams, a key tool in systems-thinking for sustainable consumption, to show how specific combinations of policy, market and civil society initiative might bring about lifestyle leapfrogging in China and India in the domains of housing and mobility respectively. Section 6 concludes by presenting a critical assessment of the lifestyle leapfrogging concept and suggesting areas for future research.

2. Conceptual framework: Combining environmental leapfrogging and systems thinking for sustainable consumption

2.1 From environmental leapfrogging to lifestyle leapfrogging

Sustainable development requires the explicit consideration of environmental issues such as ecosystem degradation, resource depletion and rising greenhouse gas emissions as driven by economic growth and development. The concept of technological leapfrogging which focuses on competitiveness and global market shares of industry sectors, has been modified and extended to develop the idea of environmental leapfrogging, to address the issue of sustainable industrial development in developing and emerging econmies (Perkins, 2003; Sauter and Watson, 2008).

Environmental leapfrogging proposes environmentally-oriented development alternatives in the greening of production processes (Ho, 2005). The concept offers, at least in theory, the prospect that emerging countries can avoid replicating the historical polluting and resource intense development trajectory of the industrial West and shape their development to meet their own needs and requirements (Goldemberg, 1998). Figure 1 provides a visual representation of an environmental leapfrogging pathway to achieve sustainable development.

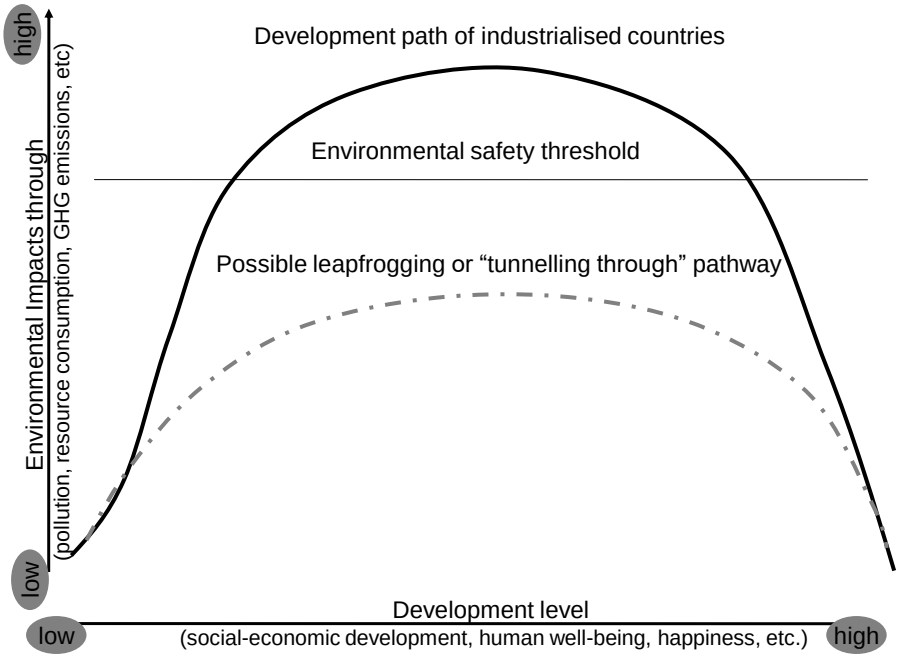

Figure 1: The process of leapfrogging using strategies for sustainability (Sources: Munasinghe 1999; UNEP-DTIE 2006; Berrah *et al.* 2007)

Just as there is debate about whether industry sectors in developing countries have indeed leapfrogged ahead of industrialized countries in terms of competitiveness, innovation and market shares (e.g. Hobday, 1994), opinions are divided about the applicability of the concept of environmental leapfrogging in newly industrializing developing countries and emerging economies. While some consider it both possible and necessary (Goldemberg, 1998; Choucri, 1998, Tukker, 2005), for others the concept is problematic and has attracted considerable

skepticism. Empirical evidence on technological change in many developing countries tends to lend more support to the idea of slow incremental technological changes, rather than radical changes and leapfrogging (See Perkins, 2003, Ho, 2005, Rock, 2008). Additionally, many have pointed out that the Environmental Kuznets curve which is implicit in the environmental leapfrogging concept does not apply to many types of environmental impacts, notably greenhouse gas emissions (GHG) which have continued to rise in developed countries even after they achieve a "high" development level (Spangenberg, 2001; Stern, 2004). Nevertheless, despite these criticisms, the idea of leapfrogging offers a powerful conceptual tool to consider alternative development trajectories.

To date, leapfrogging scholarship has been disproportionately focused on technological solutions, focusing mainly on the greening of the production process through technological innovations and failing to bring the domain of consumption or human behavior under its purview. This neglect of so called 'soft' factors such as consumer behavior and consumption patterns has significantly limited the explanatory and transformative power of the idea of leapfrogging. Our work extends the idea of leapfrogging into the domain of consumption and behavior to ask if and how consumers in developing and emerging economies might adopt sustainable consumption practices *from the outset*, side-stepping the resource intense consumption patterns of the developed world. In the next section, we briefly review the literature on sustainable consumption approaches, highlighting two main variants: strong vs. weak sustainable consumption, and bring these into conversation with the conceptual tool of lifestyle leapfrogging.

2.2 Sustainable consumption

Consumption, what, how much, and by whom, has direct and indirect effects on ecosystems. The greenhouse gas emissions produced through consumptive activities are especially important in the context of climate change (Davis & Caldiera, 2010). The inertia of lifestyles and the difficulty of achieving pro-environmental behavior in developed countries (Jackson, 2005; Jackson, 2008) is increasingly recognized as an important barrier to solving environmental problems (Whitmarsh, 2009). The literature on socio-technical systems (e.g. Geels, 2010) and eco-innovation (e.g. Bleischwitz et al., 2009) also emphasizes the need to consider the "human element" in systemic changes for sustainability. It is now becoming apparent that individuals and their daily consumption choices such as driving personal automobiles, eating food, taking vacations, and using electricity in the home matter as much if not more than technical processes on the supply side (Sovacool, 2014).

Whilst the use of terms like sustainable lifestyles and sustainable consumption is becoming ubiquitous, critical engagement with the concept is still limited (Sedlacko et al., 2014). Most uses of these terms are best characterized as representing a form of "weak sustainable consumption" (Lorek & Fuchs, 2013) which fundamentally focuses on improving the eco-efficiency of consumption activities, but does not seek any absolute reductions in consumption levels or fundamental shifts in consumption patterns (Fuchs and Lorek 2005). Weak sustainable consumption approaches include campaigns that seek to promote green purchasing behavior and product choices (Young et al., 2010) which require increasingly complex decision-making processes by the consumer alongside looking to improve the efficiency of production and distribution processes via technological innovations.

Weak sustainable consumption is contrasted with strong sustainable consumption, where the goal is a systemic shift in consumption patterns resulting in absolute reductions in consumption levels and the environmental impacts they produce. Strong sustainable consumption requires an explicit focus on the sociological and psychological factors determining consumption choices including social identity, habits and practices related to values and cultural norms (Evans and Jackson, 2007), alongside a consideration of the political economy and the socio-technical systems within which consumption practices are embedded. Strong sustainable consumption also goes beyond viewing individuals simply as consumers of products, but also acknowledges their other identities as community members and (ecological) citizens (Seyfang, 2006, 2010). Strong sustainable consumption thus is fundamentally about reconfiguring social practices (Warde, 2005) and the political-economic and socio-technical regimes in which they are embedded (Hargreaves et al., 2013), and in our opinion, about finding balance between reformist efforts that focus solely on green purchasing and eco-innovations and radical approaches that call for the end of consumer capitalism (Geels et al., 2015). For the adoption of green and eco-efficient products, the concept of lifestyle leapfrogging draws on Goldenberg and Oreg (2007) who, in their study on the *consumer leapfrogging effect,* focus on "laggards" who hold on to old technologies longer than other consumers, but adopt the latest technologies when their old product breaks. They jump intermediate product stages of less advanced technologies to latest innovations. Goldenberg and Oreg (2007) specifically raise the question of how late adopters of new technologies, can be incentivized to make the switch to the latest technologies earlier than normal. This question is relevant to emerging consumers in developing countries, "laggards in

consumption", and the potential to achieve uptake of eco-efficient products from the outset. Sauter and Watson (2008), in their discussion on technological leapfrogging, also emphasize the potential involvement of consumers to support leapfrogging through adoption of efficient products. The adoption of the most efficient technologies available to households can include efficient lighting, energy efficient appliances and electronics, the installation of solar water heaters or even solar PV home systems, highly efficient vehicles, increasingly even electric vehicles.

3. Lifestyle leapfrogging for weak sustainable consumption in India and China

Just like there has been a significant focus on "greening" consumption through market-based alternatives in the global north, lifestyle leapfrogging to "weak" sustainable consumption is already taking hold in emerging economies. Some level of lifestyle leapfrogging for weak sustainable consumption is already taking place in India and China, where government and businesses are promoting various forms of green consumption.

3.1 Green consumption of energy efficient appliances in China

In China a wide range of government policies support green consumption and the uptake of more efficient products, have been implemented in China. For example, in 2008 the government launched the 'Financial Subsidies Fund of Promoting High Efficient Lighting' to enable Chinese consumers to afford the initial purchase of compact fluorescent lamps (CFLs). The electricity consumption for lighting accounts for more than 10% of the total electricity consumption in China (Han, 2009). Initially in 2008, 62 million CFLs were subsidized through the fund; in 2009 this number rose to 120 million and to 150 million in 2010. Another development regarding the uptake of green and energy efficient products in China is the diffusion of solar water heaters which are being used by more than 200 million Chinese people. The application of solar water heaters in the building sector has already enabled several Chinese cities to achieve technological leapfrogging in buildings (Schroeder and Chapman, 2014) and the technology is installed in more than 10 percent of all Chinese homes (Huang and Gong, 2010), accounting for about 64 percent of global installed capacity (REN21, 2015).

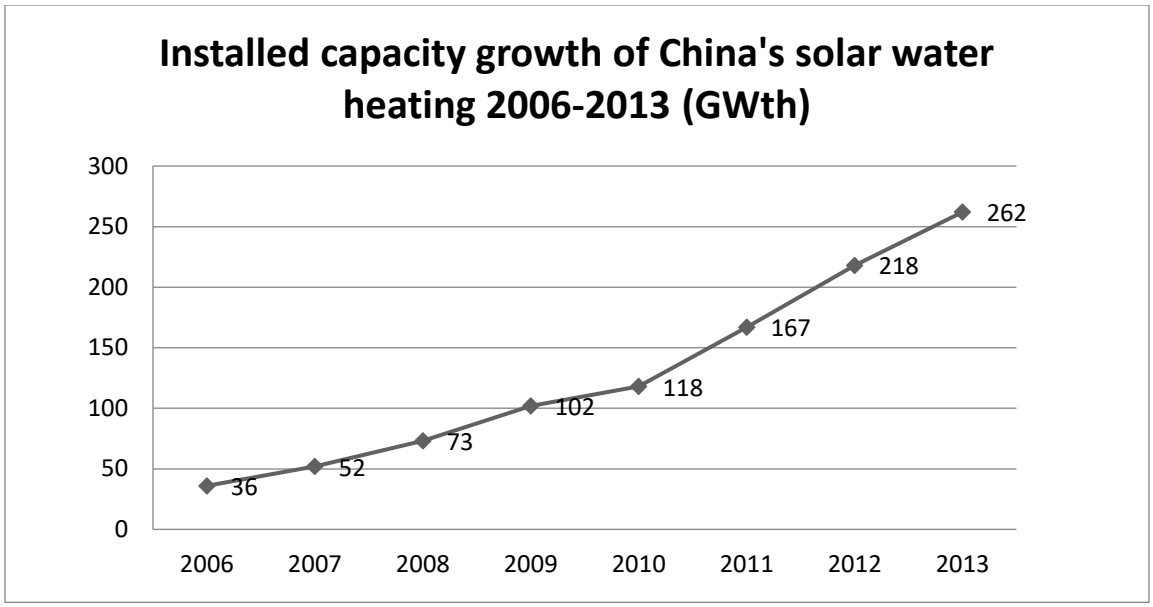

Figure 2: Growth of installed capacity of China's solar water heating collectors 2006-2013 (authors' assessment based on data from REN21 (2015) and information provided by the China Renewable Energy Industry Association).

Overall, however, the uptake of green products is slow, despite supportive policies. Liu et al. (2010) identified low environmental awareness, perception of little personal responsibility as consumer and lacking available information on green products as significant obstacles to green purchasing decision. Also, behavioral changes, for instance to reduce electricity consumption patterns in households through conservation, prove difficult to implement. Awareness among the older generation in China to save energy is in general very high, however, among younger generations this awareness seems much less developed. For example, according to a regional study about consumer attitudes relating to energy use in Liaoning Province, roughly half (45 percent) of the respondents reported that they have never thought about conserving electricity or energy efficiency before, and 10 percent of the respondents stated that, although they knew how to save electricity, they decided not to (Feng, Sovacool and Vum, 2010). These issues suggest that green consumption efforts has limited potential to truly reset the development and consumption trajectories in China,

3.2 Green consumption of energy efficient products in India

The Indian government has introduced a number of measures to increase the uptake of energy-efficient products. India faces a severe energy shortage and imports much of its fossil fuels (McNeil et al. 2008). As part of the Energy Conservation Act 2001 the government instituted the Bureau of Energy Efficiency, statutory public body that devises and implements measures to reduce the energy intensity of the Indian economy (Balachandra et al. 2010). The Bureau of

Energy Efficiency (BEE) introduced a voluntary rating system for appliances like Air Conditioners and Refrigerator in 2006. Since 2011, mandatory norms and labeling standards have been introduced for four product categories, air conditioners, refrigerators, tubular fluorescent lamps and distributive transformers, with eight other appliance categories having voluntary labeling systems. BEE estimates that these labels have alleviated the need for additional energy-generation capacity in the 2007-12 period by 7 GW (i.e. in the absence of these initiatives the Indian economy would have had to have generated another 7 GW of electricity to support its production and consumption functions) (Chaudary et al., 2012). The other space where the government has made efforts to influence the uptake of more efficient options is in the residential and industrial lighting sector. Through its *Bachat Lamp Yojana* program, the BEE has tried to reduce the electricity demand for lighting, which constitutes approximately 20 % of the total electricity demand in the country. (Chaudhary et. al. 2012). The construction of LEED certified energy efficient buildings and the development of an energy-efficiency building code for residential and commercial complexes is another initiative that aims to reduce the consumption of energy in households (Chaudhary et. al. 2012).

Policy efforts to encourage some forms on green consumption are complemented by growing environmental awareness of the impacts of daily activities. Some surveys have shown that many urban Indians are willing to adopt eco-friendly practices, even at a cost. For example, a 2012 survey of attitudes towards environmental issues in India showed that a majority of survey respondents favored policies that would reduce the environmental impacts of consumption activities. Policies that had support included increasing the cost of energy to ensure less of it is used and requiring that new automobiles be more fuel efficient (Yale Project on Climate Change Communication, 2012). However, by and large, these efforts at promoting green consumption options are few and far in between, and have failed to have any impact on overall environmental impacts from consumption in India, particularly in Indian cities.

4. Lifestyle leapfrogging to strong sustainable consumption

While lifestyle leapfrogging to weak sustainable consumption through the uptake of efficient products offers some possibilities for reduced environmental impacts, it falls short of enabling systemic shifts to sustainable lifestyles. Lifestyle leapfrogging to *strong* sustainable consumption would entail a qualitative shift in consumption practices through the use of the most efficient technologies available *and* behavioural changes which would still result in an increase of "quality of life", but would not result in an increase of overall material consumption comparable to the level of consumption levels in western consumer societies.

Therefore, for emerging consumers, lifestyle leapfrogging would also require some form of *resistance* to the adoption of unsustainable western-style consumption patterns. It would *not* require downshifting or simplifying from a state of over-consumption (Jackson, 2008), as is required for many consumers in western societies and those consumers in developing countries already following western lifestyles. Instead, it would mean *maintaining* a level of moderation in material consumption patterns, and in the case of rise from poverty, achieving a moderate consumption pattern and *not* adopting certain consumption patterns with high environmental impacts, such as urban transport by private cars, meat intensive diets, excessive accumulation of electronic gadgets and household appliances or holiday travel by plane, for example.

Resisting western consumption patterns can prevent "lock-in" and path-dependency of lifestyles. In the context of climate change, "carbon lock-in" not only applies to carbon intensive infrastructures and investment, but also to lifestyles and social activities with high carbon intensity (Maréchal, 2010). If people's beliefs, habits and behavioral patterns center around having an energy-intensive lifestyle based on the current "American model", such a lifestyle could become a key part of an overall social and cultural pattern of behavioral carbon lock-in that includes high carbon technologies and infrastructures, and associated cultures, institutions and policies (Wang and Watson, 2009; Unruh and Carrillo-Hermosilla, 2006). Developing countries such as China and India are characterized by societies that are already changing rapidly. It might therefore prove easier to guide the direction of this transition towards sustainable lifestyles than achieving this in more stable developed countries with locked-in consumption patterns.

An additional dimension are the so-called "downshifters" or voluntary simplifiers who consciously reduce levels of consumption and seek for alternatives to consumerism, resulting in behaviors that produce fewer GHG emissions (see Swim, Clayton and Howard, 2011). According to Lee et al. (2011), further distinctions can be made between "anti-consumption" behavior and consumer resistance, although overlaps exist. Anti-consumption mainly entails three phenomena: reject, restrict, and reclaim. In processes of rejecting, individuals intentionally and meaningfully exclude particular goods from their consumption cycle. Restricting incorporates cutting, lowering and limiting consumption of specific goods and services when complete anti-consumption is not possible. Reclaim represents an ideological shift regarding the processes of acquisition, use, and dispossession, e.g. voluntary simplifiers reclaim their identity via production instead of consumption, when they choose to grow their own vegetables rather than acquire them through conventional markets. In comparison, consumer resistance focuses on consumers opposing a dominant force or structure exerted by certain actors, behaviors, and devices. For the three demand areas with the highest impacts food & drink, housing and

mobility, as identified by the EIPRO Study (Tukker et al, 2006), some options and elements necessary to achieve strong sustainable consumption behavior are listed in Table 1.

Table 1: Building blocks for strong sustainable consumption in the domains of food & drink, housing and mobility.

Type of approach	Food & Drink	Housing	Mobility
Green consumption	Choice of organic food & fair trade products from large retailers	Energy efficient housing, choosing green power provider, renewable energy applications for buildings (e.g. solar water heating, solar PV, heat pumps), green building materials, energy efficient appliances	Purchase and use of fuel efficient cars, electric vehicles, fuel cell vehicles
Anti-consumption (reject, restrict, and reclaim)	Rejection of highly processed food, supporting locally grown food & farmers markets, urban gardening initiatives and home-grown vegetables & fruit	Reduction of appliances in the home, turning off appliances, use of alternative heating and cooling solutions, voluntary behavioural changes of occupants	Voluntary choice of public transport, cycling, walking, car sharing
Consumer resistance	Opposition to fast food chains, factory farming, etc.	Resistance to fossil-fuel based power providers, opposition to large unsustainable real estate developments and real estate speculation	Neighbourhood initiatives for car-free zones, opposition to new highway and road constructions

We would argue, to prevent both direct and indirect rebound effects (Sorrell, 2007) which can become serious problems for developing countries as consumption of energy services is not yet

saturated (van den Bergh, 2011), the strong sustainable consumption dimension of lifestyle leapfrogging incorporating elements of anti-consumption behavior is crucial The focus on changing behaviors and practices to achieve not only relative, but absolute reductions in environmental impacts through reduced consumption, as advocated by environmental groups (e.g. Friends of the Earth, 2004), is therefore also relevant for emerging consumers in developing countries, even if technical efficiency improvements and uptake of greener products take place. In other words, we need lifestyle leapfrogging even if environmental leapfrogging occurs. There is possibly also a larger role for consumer resistance in form of social and political activism where traditional lifestyles and existing sustainable consumption patterns are being eroded, e.g. in the demand area of food through unhealthy western-style fast food diets.

Whilst the contribution of social and behavioral changes to leapfrogging pathways is difficult to quantify, the research cited above suggests that behavioral changes play a much larger role than often assumed, possibly also for developing countries. The modest scale of behavioral changes towards sustainable consumption thus far, relative to the growth in demand for western-style consumption, might be an explanation of why many technology leapfrogging attempts in developing countries have so far resulted in improvements of resource and energy intensity, but not yielded absolute reductions in environmental impacts such as air pollution, GHG emissions, water pollution or waste. Lifestyle leapfrogging to strong sustainable consumption would be desirable as high individual energy and resource consumption patterns can offset reduction of environmental impacts, despite the occurrence of technological leapfrogging giving rise to efficiency improvements.

Clearly, lifestyle leapfrogging will not occur without strong policy instruments to enable the uptake of green products from the outset and strong measures to persuade new consumers' resistance towards unsustainable consumption patterns, before lock-in effects take effect. Several policy approaches could be instrumental in providing incentives for eco-innovation and creating a demand for less environmentally damaging technologies and products. Generally, developing countries are lagging behind in the implementation of environmental policies (Ho 2005), therefore the early adoption of environmental policies by developing countries will be an important factor to facilitate sustainable lifestyles. Also, early implementation of policies that would internalize environmental costs on a macro-level, such as a price on carbon either through carbon taxes or emissions trading schemes, would be necessary. More specifically, product related policies based on life-cycle assessments, such as efficiency standards for products, sophisticated labeling schemes to inform and guide consumers, mandatory take-back schemes and recycling systems are needed. Finally, policies which limit or even restrict the sale and use of environmentally and/or socially damaging products would be useful.

A variety of concrete approaches addressing social-psychological factors can also be applied to bring about the changes in consumption patterns, or more specifically, to encourage emerging consumers to resist becoming western-style consumers. Setting basic advertising norms for certain products to protect vulnerable target groups such as children, combined with raising basic environmental awareness and education about the impacts of consumption, would be worth exploring. These policy changes have to be supported by the work of civil society and social movements that could aim at strengthening values, attitudes and personal norms which counter the spread of materialistic and consumerist attitudes and resist consumption patterns characterized by accumulation of material possessions. These suggested policy instruments and approaches are not fundamentally different from those necessary in consumer societies, with the important difference that in developing country societies these would need to be implemented *before* unsustainable lifestyles become entrenched. Nevertheless, it must be acknowledged that certain facets of 'unsustainable' lifestyles are already entrenched in some sections of society in developing countries, and lifestyle leapfrogging will require undoing some of these "lock-ins."

5. A systems-based approach for engendering lifestyle leapfrogging

As the previous section demonstrates, lifestyle leapfrogging to strong sustainable consumption will require an explicit analysis of the various drivers of consumption practices, and devising specific policy interventions. Such an analysis requires looking at the whole system of consumption, and understanding of changes in one domain can have ripple effects. Systems thinking methods, emerging from the fields of cybernetics and statistical mechanics offer valuable tools to carry out these types of analysis.

Systems thinking is an analytical perspective which views an event or a system in a holistic manner by placing explicit emphasis on the relationships and interactions between the system's elements and constituents and examining system properties that emerge from the interaction of individual elements (Senge, 1990). Key elements of systems thinking for sustainable consumption include the consideration of feedback cycles between different elements of consumption and production systems, system dynamics and a system's boundaries. Systems-based analysis have been applied to various problems of sustainability transitions and sustainable consumption, for instance the reduction of barriers to energy efficiency (Chai and Yeo, 2012) and in exploring mental models for sustainable consumption (Sedalcko 2014.)

The contribution of systems thinking to sustainability transitions has been summarized by Fath (2014), distilling ideas from three leading systems thinkers including Niklas Luhman (e.g. 1992), Bernard Patten (e.g. 1978, 1991) and Christopher Alexander (1964, 2012). Foundational concepts in systems theory are boundaries and input–output oriented interactions. For example,

output of one object, through a series of direct linkages, indirectly connects back again as input to the original generating object. Thereby processes embedded in and contributing to a larger system provide positive and negative feedback such that their actions close back around on the function itself (Fath, 2014). Drawing on Alexander (2012), one additional important feature of sustainable systems is that the system boundaries are not crisp but fuzzy, and that multiple systems can overlap. Furthermore, the center of a system engages in interactions which aim at structure-preserving transformations. In other words, stable systems have both positive cycles and negative cycles (also known as reinforcing loops and balancing loops in Causal Loop Diagrams), that work together to maintain system stability. Understanding this concept of structure-preserving transformation of a system, can be helpful in understanding how and why systems can become locked-in, and when they might be unbalanced, and can then be transformed.

Systems thinking perspectives enables the examination of endogenous causes of stability and change and help us avoid falling into the trap of assuming that barriers to change are solely caused by external events Rather, systems thinking enables the examination of endogenous causes of stability and change. Furthermore, a systems perspective dissolves the perception that barriers are independent of each other and enables the examination of emergent properties that can only be understood by considering the whole as opposed to the sum of parts. This would mean strategies aiming for strong sustainable consumption need to consider the interactions and feedbacks between technological and behavioural system components.

In the following two sub-sections, we apply systems thinking to two case studies to explore how lifestyle leapfrogging to strong sustainable consumption could be brought about. We focus on two systems, sustainable mobility in Indian cities and energy efficient residential buildings in China. We distinguish three main dimensions of each system - policy, market and society – and describe the interaction and positive and negative feedback cycles between the elements either driving or preventing lifestyle leapfrogging. In particular, in this paper we follow Sedlacko et al. (2014) who use Causal Loop Diagrams (CLDs) to explore the potential for promoting sustainable consumption. In this paper CLDs are used as conceptual tool to explain system dynamics of China’s residential energy efficiency and low-carbon mobility in India. The outcomes of the analysis have been visualized through a combination of CLDs (see Sedlacko et al., 2014) and the graphical presentation of the environmental Kuznets curve used for visualizing leapfrogging processes (see Figure 1). The results of this combination exercise are Figures 4 and 8 below which depict two pathways (business-as-usual and leapfrogging) and the respective drivers for each pathway. The drivers for each pathway automatically act as barriers to the other pathway, thereby maintaining stability of the system.

In addition, we constructed separate CLDs which depict the interconnections between drivers and barriers of the different system variables of policy, market and society (Figures 3, 5, 6 and 7). In these CLDs, + indicates positive feedback and reinforcing loops, while – indicates negative feedback and balancing loops. The double slash on the connection indicates that the feedback takes place on a longer timescale. Further explanations about the specific contents of the CLDs are provided below.

We constructed the CLDs for China and India based on various sources of information. First, literature reviews on energy efficient buildings in China and low-carbon mobility in India were carried out. Secondly, interviews with stakeholders from the fields of housing and mobility were carried out in China and India. The Indian CLDs were constructed using data collected over 15 months of fieldwork by author Anantharaman in Bangalore, India, studying the scope and potential for non-motorized transport and public transit in Bangalore, India. During this fieldwork, Anantharaman interviewed 25 individuals and organizational representatives involved in promoting bicycling and public transit in Bangalore, in addition to interacting with policymakers in official forums. Fieldwork data was combined with insights from media articles on urban mobility in Bangalore and other Indian cities to present the information below.

Furthermore, for the CLDs on China, the author Schroeder conducted site visits to residential construction projects in Shenzhen, Beijing and Nanjing in October 2015. Interviews with ten experts and stakeholders from China's building sector provided further information about the relationships and dynamics between different system elements.

5.1 Leapfrogging towards low-energy housing in China

The number of people living in urban areas in China increased between 1980 and 2000, growing from 193 million, or 19.5% of the total in 1970 to 451.8 million (Zhou et al., 2009), or 35.6% of total in 2000. China's urbanization rate reached 51 percent by the end of 2011 and is expected to 60 percent by 2020, bringing the country's urban population to around 850 million (Xinhua, 2012). China's urbanization rate increases yearly by over two percent, as a result the building sector is expected to experience an increase of 2 billion square meters of buildings every year until 2020 (Tsinghua University Building Energy Research Center, 2008). The residential housing sector in urban areas accounts for about 32% of China's floor space (Tsinghua University Building Energy Research Center, 2012). This trend of urbanization, together with rising energy consumption in urban areas, will lead to the building sector accounting for 35-40% of China's total energy consumption by 2020. The large number of new residential buildings needed for the growing urban population shows that there are significant leapfrogging potentials in the short and medium term, if low energy housing is promoted in a systematic approach. The

CLD of Figures 3 depicts the systemic barriers, the interactions and feedback loops between different system variables of low-energy housing in China. In particular, it shows the positive and negative feedback loops of reinforcing or balancing loops between the different system variables of policy, market and society.

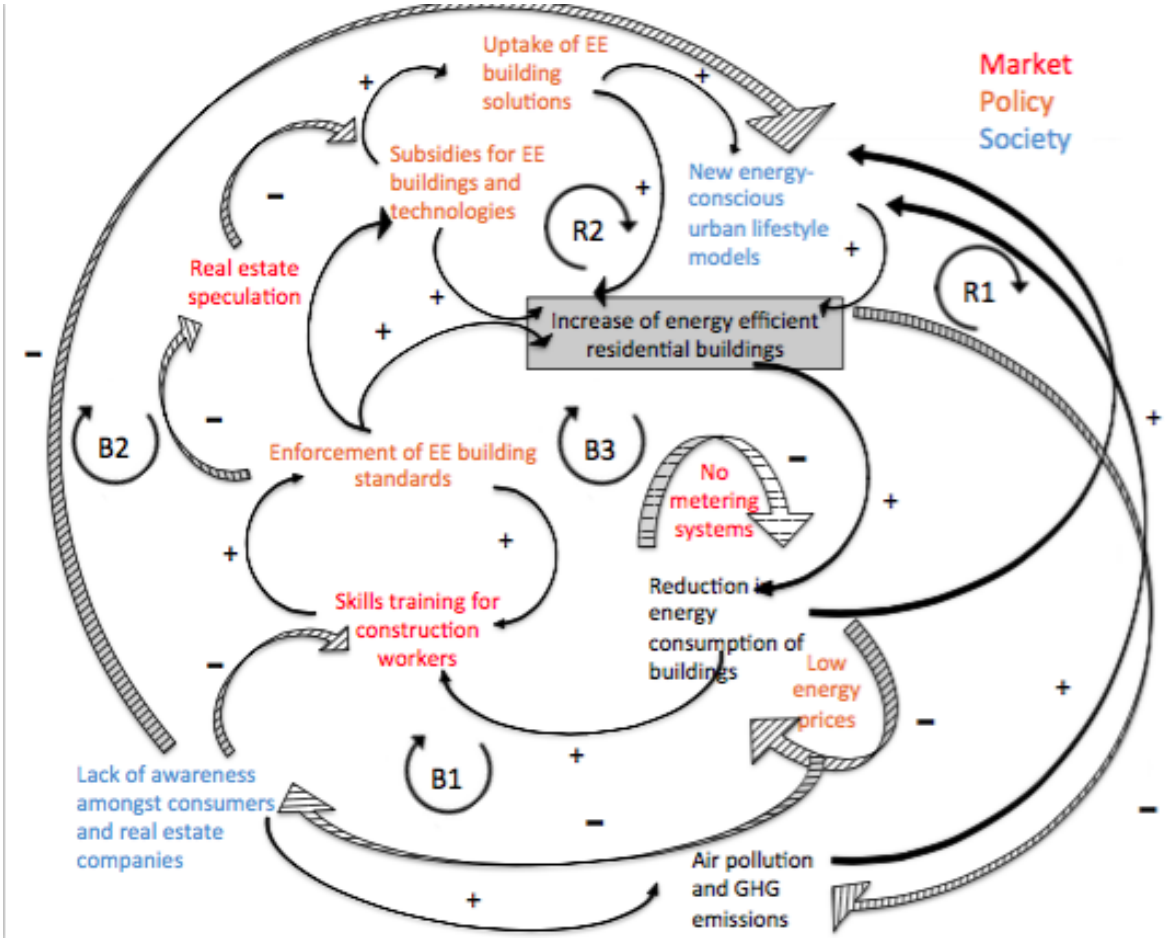

Figure 3: Causal Loop Diagram (CLD) showing interconnections between system variables of low-energy housing in China

As the detailed relationships and interactions between various barriers and drivers to energy efficient housing in China are complex, they can here only be described in a general way that does not take into account regional differences. Overall, the current situation is characterized by a major policy barrier, which is the lack of enforcement of energy efficient building codes for residential buildings on local level. This is closely related to the fast pace of the over-heated Chinese real estate market and speculation, which have driven up housing prices beyond

affordability for many families (B2). To reduce costs of construction, many companies mainly rely on underpaid migrants from the countryside, often without specific skills (B1). However, the correct application of advanced energy efficient building materials require a certain set of skills, in addition, they have often higher costs than conventional materials, both of which are barriers to their uptake. The enforcement of energy efficient building standards is a crucial policy element for the leapfrogging pathway, as it would arguably put a brake on real estate speculation and at the same time stimulate subsidies as well as skills training for construction workers. In turn, this reinforcing loop (R2) would facilitate enforcement and gradual improvement of building standards and lead to higher quality and better building performance.

The generally low energy prices in China are another barrier to stimulating energy saving behavior of residents. Furthermore, lack of heat metering systems in residential apartments acts against reduction of energy use in buildings (B3). Based on the current model, centralized space heating is provided during the winter months to most residential buildings based on a flat rate that is calculated according to floor space, not based on actual usage. In most cases residents do not know how much energy the consumer for heating. Besides this, heating systems in many cases cannot be switched off or residents cannot adjust indoor temperatures manually. If indoor temperatures are too high for comfort, windows are opened to reduce indoor temperature. The installation of heat metering systems (technical/market dimension) combined with energy pricing reform for heating (policy dimension) is an example of how these changes can affect behavioral changes of occupants (social dimension), another crucial element for the leapfrogging pathway. The installation of heat meters, radiators with adjustable temperature regulators in new buildings and, most importantly, a pricing reform that will reward energy saving behavior of residents can facilitate strong sustainable consumption in the domain of housing for tens of millions of China's new urban residents.

For electricity used in residential buildings, the Chinese government has already begun the implementation of a tiered electricity pricing system to encourage energy efficient consumption behaviour and to increasing residents' awareness. In July 2012, the electricity departments in China reformed electricity prices to a tiered electricity power tariff (*jie ti dian jia*) for residential energy users across China. The goal is to form a market-oriented price scheme where the market plays the main role, while the macro-level national policy controls and sets the basic standard. The Chinese government estimates that 5% of the population – the very highest income earners – account for 24% of domestic electricity consumption in China, while the top 10% use 33% of electricity (Cui, 2012). The tiered power tariff aims to address this group of consumers in particular. The challenge with such an instrument is the huge income gap within the Chinese population. There is the danger that such an instrument is regressive and could negatively impact

on low-income groups. Overall, the tiered power tariff coupled with other measures can lead to a reduction in energy consumption in residential buildings.

In the social domain, changing lifestyles of urban residents are emerging as a major driver for increasing energy demand from residential buildings. The impact of human behaviour upon energy use has in many cases already outpaced technical improvements in China's building sector. Energy use (excluding heating) in residential buildings is still lower than in developed countries. This is mainly due to different lifestyles and habits that are dominant in local society and the community, such as part-time and part-space operation of cooling/heating devices, opening windows for natural ventilation, keeping warmer clothing for lower indoor set temperature, etc. However, these "anti-consumption" practices of the older generation are lost as more people from the countryside move into cities and western building designs and structures are adopted, the energy consumed per capita due to the lifestyle habits the Chinese urban consumers increases. This is especially true for younger people who follow western lifestyle models with low consciousness about energy consumption, acting against a leapfrogging pathway. Specific research on the interconnections between occupant behaviour, household needs, consumer choices and lifestyle issues in China is so far limited, but necessary to further understand the role of these factors in driving or preventing energy efficient housing solutions.

One important element influencing consumer awareness and lifestyle choices, which only emerged in recent years, is the worsening air pollution in Chinese cities. It is to a large degree a result of the current energy and heating supply system and partly the result of energy consumption habits of urban residents. As air quality worsens and negatively impacts the health of tens of millions of urban residents, it positively impacts awareness about sustainable consumption choices and thereby acts as a positive driver for the market as consumers demand more energy efficiency buildings (R1). One can also begin to observe the emergence of elements of "consumer resistance" against the political and economic causes of air pollution, which also is having impact on policies.

Figure 4 combines and synthesizes the leapfrogging concept and the elements of the CLD above, and shows two possible pathways for China's housing development. First, business-as-usual development which would lead to a growing stock of inefficient residential buildings, thereby locking Chinese cities into high energy consumption trajectories. Secondly, a leapfrogging pathway for the residential building sector, which would bypass the situation of lock-in into a low-efficiency building stock.

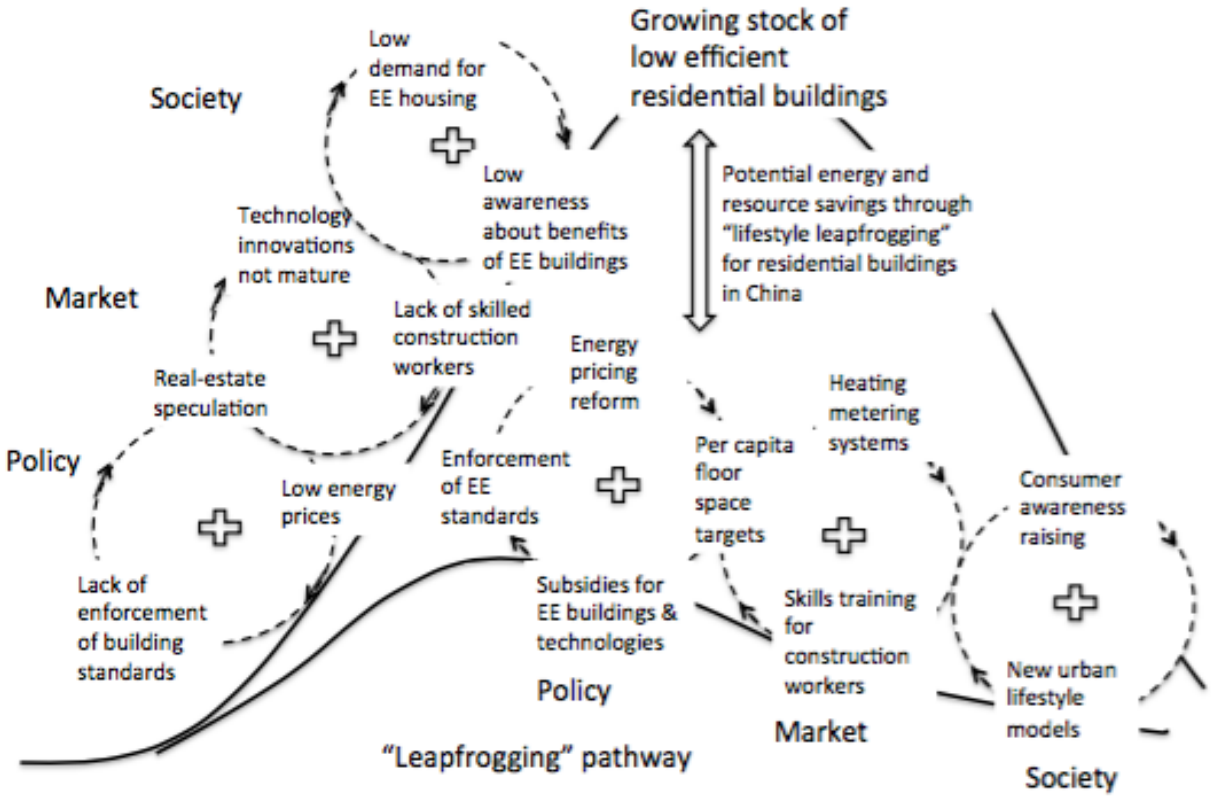

Figure 4: Leapfrogging Causal Loop Diagram (CLD) contrasting "lifestyle leapfrogging" towards low-energy housing in China and business-as-usual development

5.2 Leapfrogging towards sustainable urban mobility in India

The ownership and use of personal automobiles in India has been growing steadily for the past three decades, particularly in its cities. The liberalization of the Indian economy beginning in the late 1980s heralded the arrival of a wider variety of car and motorcycle brands in the nation. As new consumption options became available, export and Foreign Direct Investment driven growth produced new opportunities and rising incomes for a section of the Indian population, prompting the emergence of a new middle class that practiced global consumer lifestyles (Fernandes & Heller, 2006; Mawdsley, 2004; Upadhya, 2009). As India began to grow a consumer economy, cars soon solidified their position as a key middle class status marker (Baviskar, 2011). This bevy of consumption options combined with an emergence of a "new" middle class of

consumers opened the floodgates to the rapid automobilization of Indian cities, which have traditionally had high rates of bicycling, walking and public transit use.

The causal loop diagram depicted in Figure 5 demonstrates how factors operating at the policy, market and society levels combine to prompt the rapid automobilization of Indian cities. In India today, the use and ownership of cars and motorcycles is a critical way of signaling social status and "having made it." Car and motorcycle advertisements, which are constantly played on most television channels, sometimes cover the front pages of newspapers, and pepper city landscapes in the form of massive billboards, play on themes of cool, comfort, belonging and exclusion to encourage the purchase and use of personal automobiles. These advertisements also stigmatize other modes of transport like bicycling, signaling them as inferior to car use. Banks and other financial institutions team up with car manufacturers and retailers to offer financing schemes for car purchases. Consequently, Indian consumers buy cars and motorcycles as soon as they are able to afford them (Wilhite, 2008). The CLD of Figure 5 has two reinforcing loops: R1 which relates to how the city apportions its budgets and R2 related to social norms around the car. Both these feedback loops drive the system towards more car usage. The only balancing loop in this system (B1) is the feedback between traffic congestion and social norms. Indian cities are plagued by traffic congestion, which offsets the idea that cars are the most "cool" and convenient transport option available to commuters in the city.

Market forces and strong social norms are coupled with government support, and all these forces combine to change the physical form of Indian cities to accommodate cars and motorcycles. Municipal governments in major Indian cities have largely focused on improving infrastructure for motor vehicles by widening roads (often by felling trees), constructing flyovers and signal-free corridors (Nair, 2005) (loop R1 in the CLD). In an extreme move, bicycling has been criminalized in the Indian city of Kolkota (Gupta, 2013). These changes to roadways have come at the cost of other transport modes such as bicycling, walking and public transit. While there has been some effort to improve public transit options in major cities like Delhi, Chennai and Bangalore by constructing new metro systems and making marginal improvements to bus services, these have been largely subordinated to car-focused urban planning. Further, public transport companies are usually poorly funded and operate on losses, and are unable to modernize their existing fleet of vehicles (Pucher et al, 2005). The rising automobilization of Indian cities has also increased road fatalities. For instance in 2007, 961 persons were killed and 6591 persons injured by motor-vehicles in Bangalore, many of them cyclists and pedestrians (Rahul & Verma, 2013). All these factors prompt Non-motorized transit (NMT) and public transit users to "upgrade" to motorcycles and other types of automobiles when possible (Nair, 2005; Tiwari & Jain, 2013).

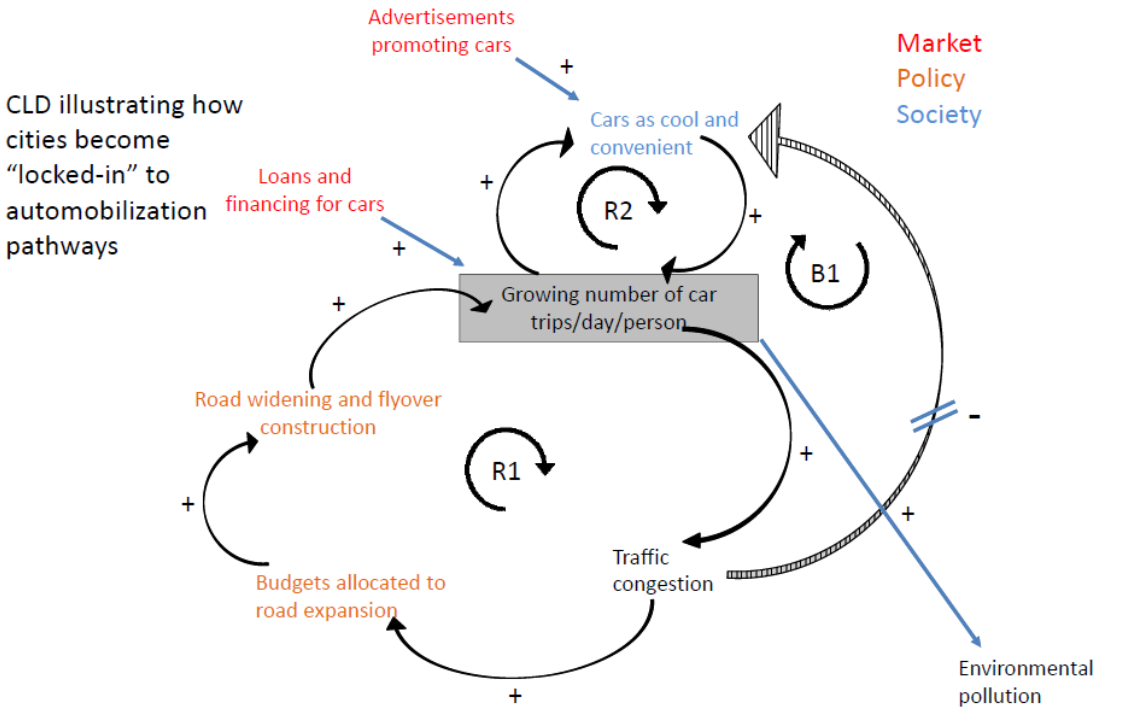

Figure 5: Causal Loop Diagram (CLD) depicting how Indian cities become locked-in to paths of rapid automobilization.

This trend of rapid automobilization could be stalled and averted through policy interventions, increased market provision of alternate transport modes, and by changing social norms around car use and status (see Figure 6). There are several social movements in Indian cities that are pushing for bicycling infrastructure and public transit. These social movements contest the dominant social norm that cars are the most convenient and status-affirming transport option available in Indian cities. Instead, they are developing alternate discourses around what constitutes a good and respectable life in urban India. These discourses frequently draw on environmental themes to motivate alternate visions, and the degrading quality of urban environments is a major motivating factor for this civil society action (Anantharaman 2016).

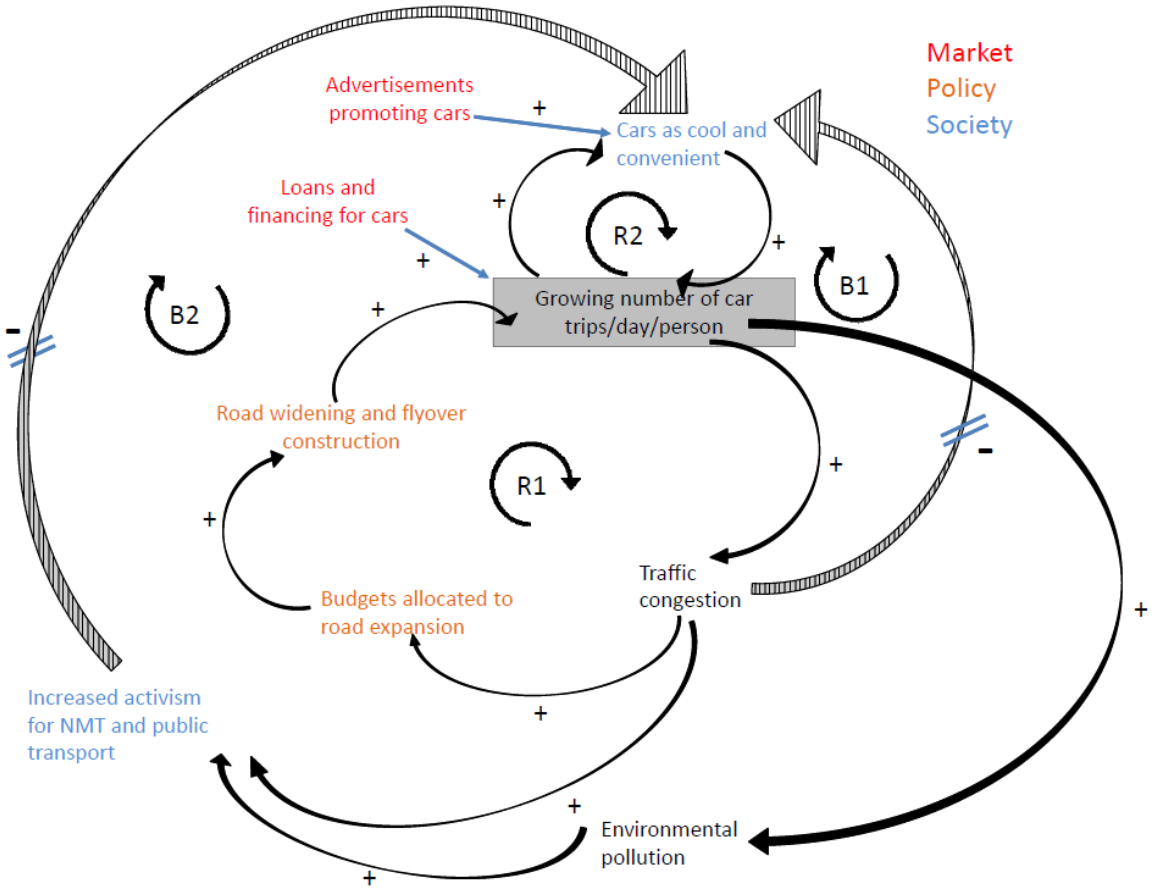

Figure 6: Causal Loop Diagram (CLD) depicting how automobilization could be countered by civil society activism pushing for more NMT and public transit options.

The CLD of Figure 6 has two reinforcing loops: R1 which relates to how the city apportions its budgets and R2 related to social norms around car. Both these feedback loops drive the system towards more car usage. However, in this CLD, there are two balancing loops: the first balancing loop in this system (B1) is the feedback between traffic congestion and social norms. Citizen activism for NMT and public transit can in the long-term help overturn dominant social norms around car use, balancing rapid automobilization (B2).

Civil society action can in turn precipitate changes in policy. The policy changes required to reverse automobilization could include increased investment in public transport and non-motorized transit infrastructure. These funds could be obtained by diverting budgets from road widening and flyover construction and by implementing congestion charges and parking fees in Indian cities, which would in turn increase the costs associated with car use. Controls could be placed on car advertisements, especially those targeting children and other vulnerable groups. Similarly, on the market side, there would have to be more options available for non-motorized

transit users like hi-tech bicycles that allow one to travel longer distances, and investment in modernizing the bus fleet with clean energy. Citizen activism for NMT and public transit can in the long-term help overturn dominant social norms around car use, balancing rapid automobilization (B3). It can also drive more budget allocation for public transit and NMT, which can in turn dampen automobilization (B1). Controls on advertising combined with increased market provision of hi-tech bicycles can help destigmatize bicycles and buses, decreasing car use in turn (B2) (see Figure 7).

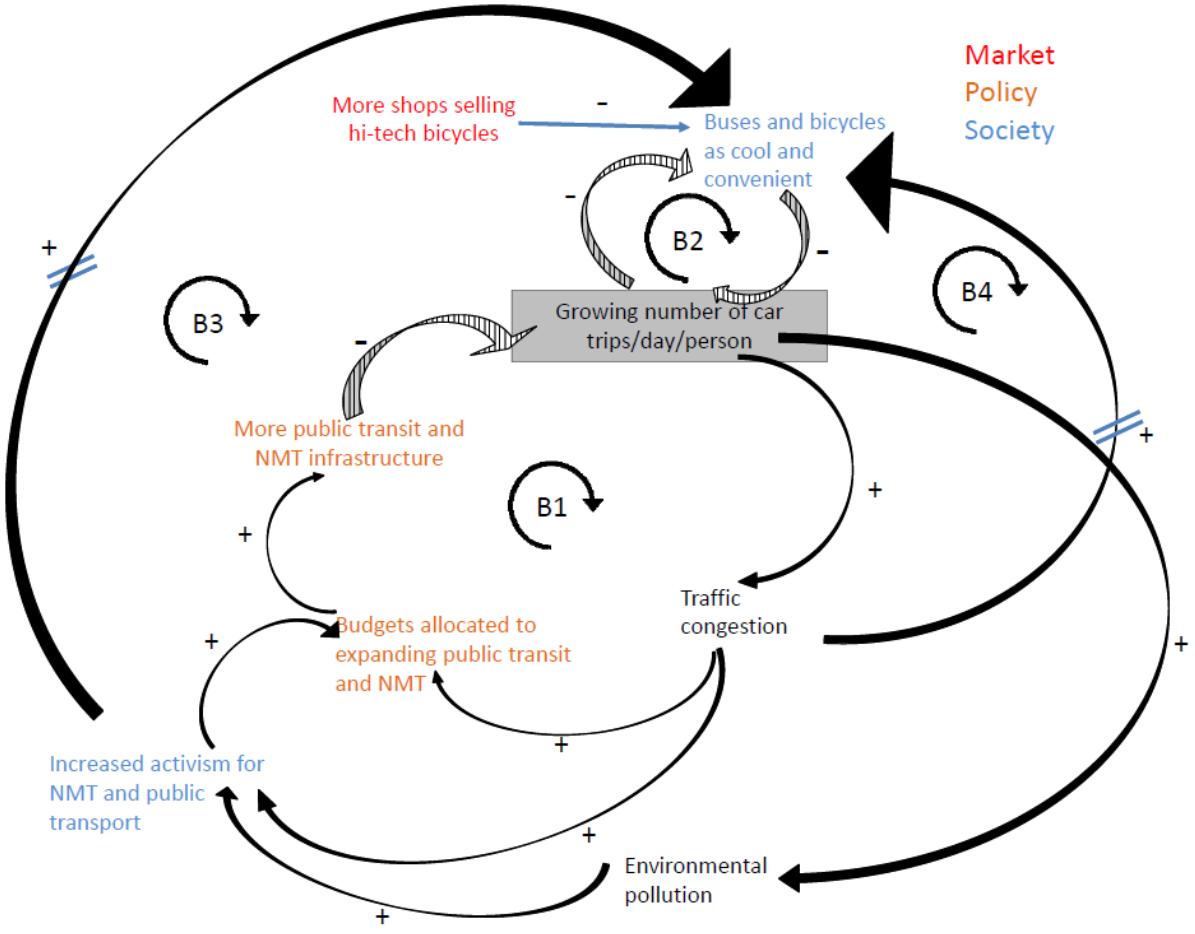

Figure 7: Causal Loop Diagram (CLD) depicting how Indian cities could rapidly deautomobilize through policy, market and civil society action.

Figure 8 synthesizes these individual CLDs to show how targeted policy, market and civil society interventions can help drive a leapfrogging towards more sustainable mobility in Indian

cities. It also presents the factors acting as barriers to leapfrogging, which "drive" business-as-usual development.

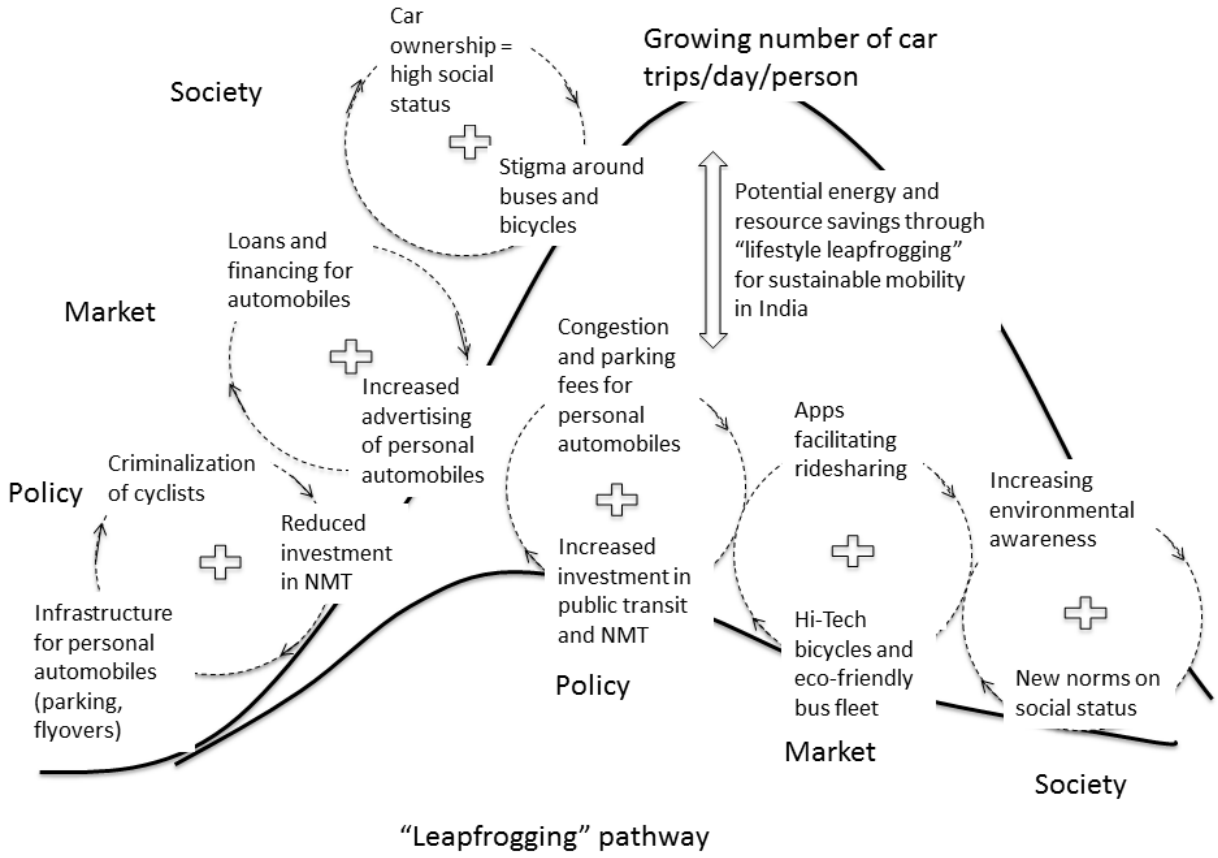

Figure 8: Leapfrogging Causal Loop Diagram (CLD) contrasting "lifestyle leapfrogging" towards sustainable urban mobility in India and business-as-usual development

6 Conclusion

The paper started out from the hypothesis that leapfrogging unsustainable consumption patterns is in theory a viable option for emerging consumers in India and China. The systems thinking analysis of two cases from China and India in the areas of residential housing and mobility show that lifestyle leapfrogging could be realized through targeted interventions in policy, market and civil society. The purpose of this paper is not to make celebratory statements about the sustainable consumption efforts being promoted in India or China, or to gloss over the fact that consumption and consumerism are overall rising in these nations. Rather, it seeks to apply systems-perspectives and the leapfrogging concept to locate mechanisms and processes by which

these trajectories could be altered. It highlights the importance of explicitly differentiating strong vs weak consumption, recognizing that any serious efforts at sustainability in these two countries will have to involve resistance and downshifting in some cases. Both case studies, although they analyze different sectors, highlight the need for strong policy action as a key driver of "lifestyle leapfrogging".

Both countries are already implementing measures that are a departure from the business-as-usual development pathway of developed countries and these can potentially enable systemic shifts in consumption patterns and lifestyles of urban consumers. In particular China's and India's consumer-targeted policies in these two areas deserve attention and can serve as examples for both developing and industrialized countries. Further research on leapfrogging potentials in other developing countries with case studies from mobility, housing and food applying systems thinking would be of interest for comparative research. Finally, while the "leapfrogging" concept might implicitly suggest that developed countries "have reached the right destination" and that developing countries only have to figure out how to get there faster, we here posit that developing countries *already* have several sustainable practices that are important to preserve. The challenge for future research and practice is to analyze and understand how to "leapfrog" past the unsustainable practices of the developed world to new and distinctive sustainable futures in emerging economies.

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