

Study of the Energy Related Properties' Impacts on the Price of Appliances on the Chinese Market

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Abstract

Topics: Lifestyles and Consume Behaviour

Key words: Price, Technologies, Energy Efficiency Tier, Energy Efficiency Indicator, Appliances

The price of the household appliances is affected by many factors, such as brand, design, dimension, quality, technology, and capacity, etc. The Chinese government implemented several rebate programs to promote the high energy efficient products, which is based on the assumption that high efficient products have higher price. The subsidy criteria are based on the technologies, capacities, energy efficiency tier and energy efficiency indicators, which are called energy related properties in this paper.

Six products are selected for the analysis, which are: air conditioner, refrigerator, panel TV, washing machine, rice cooker and monitor. All products are from the project named "Market Analysis for China Energy Efficient Products" (MACEEP) jointly conducted by Top10 China and Collaborative Labeling and Appliance and Standards Program (CLASP).

The analysis shows that the price of the appliances has very close correlation with the energy related properties mentioned above. It is strongly affected by the technologies, capacities and energy efficiency tiers. The technologies bring oblivious price differences for the air conditioners and washing machines. The price goes higher when the capacity increases. The price of better energy efficiency tier products is also higher than the lower tier products. However, the energy efficiency indicator has very weak correlation with the price of the products under the same technology, capacity and efficiency tier.

Introduction

Appliances are widely deployed in Chinese households. The ownership rate of major appliances (refrigerators, air conditioners, washing machines and TVs) in urban households is higher than 90% [1]. The huge number of appliances consumes significant electricity. In 2012, the appliances consumed more than 10.1 TWh of electricity, which accounted for more than 12% of all electricity in China [2]. The electricity consumption of the household appliances is expected to keep increasing in next years due to the social and economic development, urbanization and life style evolution [3]. The Chinese government has realized the importance of appliance energy efficiency to the national policy and goal of "Energy Saving and Emission Reduction", which is to achieve 16% reduction of energy per capita in 2015 compared to 2010 [4]. Both mandatory and voluntary policies and programs are implemented to improve the efficiency of the appliances. The mandatory policies include the minimum energy efficiency performance standards (MEPS) and energy label program. The voluntary programs include the energy conservation certification program, government procurement for energy conservation products and rebate programs. Three nationwide rebate programs have been implemented in recent years, which are the "Subsidy program for home appliance replacement [5]", the "Appliances to Rural Areas [6]" and the "Project to promote energy-efficient products for the benefit of the people [7]". The last rebate program subsidizes the products only based on the energy performance. More than 3 billion Euros will be awarded to high efficiency products in the program of "Project to promote energy-efficient products for the benefit of the people" from June 2012 to May 2013. The major household appliances are included, which are: air conditioners, refrigerators, washing machines, flat-panel TVs and water heaters, etc.

It is thought that the high price of efficient products is the hurdle for the market penetration [8]. The Chinese consumers also realized the importance of the energy saving and environmental protection in their purchasing process, as more than 90% of the consumers took the energy consumption into purchasing decision making [8]. The rebate programs are considered as one of the most effective policy measures to promote the high energy efficient products [9]. The subsidy criteria are based on the technology, capacity, energy efficiency tier and energy efficiency indicator, which are considered as the energy related properties in this paper.

The price is the first factor to affect the purchasing decision of the appliance [8]. It is affected by many factors, such as brand, design, dimension, quality, technology, and capacity, etc. This paper will analyze the impacts of the energy related properties compared to the price. The "technology" refers to the methods to achieve the same or similar functions by different or similar theory, which will lead to different energy consumption. The "capacity" is the parameter characterizing the size of the product/service, such as the cooling capacity for the air conditioners, volume for the refrigerators, screen sizes for the flat-panel TVs, etc. The "energy efficiency tier" is the indicator to distinguish the general energy efficiency performance in the energy label system. In China energy label system, there are two scales with either 3 or 5 tiers. In both scales the lower the tier, the higher the energy efficiency. The "energy efficiency indicator" is the efficiency performance indicator of the product set in the MEPS and disclose on the energy label.

The data of this paper is based on the project named "Market Analysis for China Energy Efficient Products" (MACEEP) jointly conducted by Top10 China and Collaborative Labeling and Appliance and Standards Program (CLASP). This project focuses on available product models on the retail market. Several data sources including retailers, independent market research companies and labeling program were integrated into one database for the analysis. The energy related data such as the energy consumption, capacity, energy efficiency tier and indicator, comes from the manufacturers' declaration for the products such as the nameplates, product instructions and energy labels. The price information was sampled from two large retail-chains (Gome, Suning [10]), on-line stores and independent information providers (ZOL, ETao [11]) in June 2012.

Impacts of the technology on the price

In the eight products analyzed in the MACEEP project, five products have at least two technologies. Separate energy efficiency requirements are set according to the technologies for air conditioners, flat-panel TVs and washing machines, while the rest of products regulate different technologies with the same indicators and requirements.

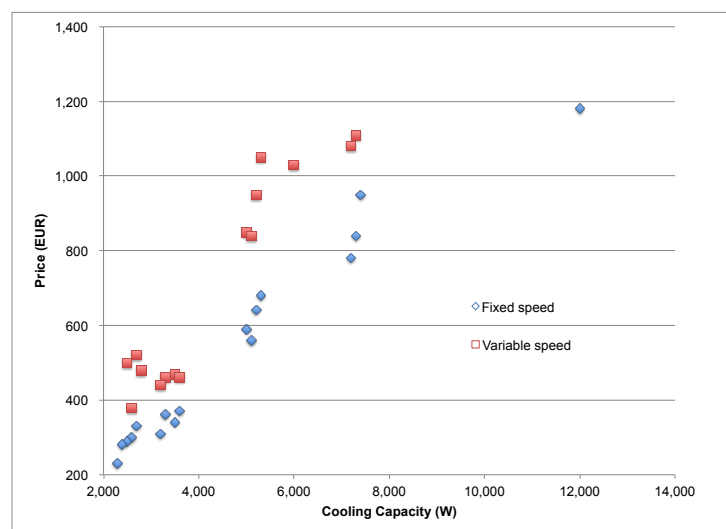


Figure 1 Cooling capacity, technology versus price of air conditioners

*n=2629

Under the same cooling capacity in figure 1, the price of the variable speed air conditioners is much higher than the fixed speed air conditioners, which is about 40% higher on average. The fixed speed air conditioner is traditional technology which appeared on the market at the very beginning of the 1980s. The variable speed technology was introduced into Chinese market in the middle of the 1990s. More than 50% consumers take the air conditioner as the most important appliance in energy saving [8]. Around 70% of consumers thought energy saving is the most important advantage of the variable speed technology compared to fixed speed technology [12]. As the air conditioner consumes significant shares of the electricity in the households, the variable speed technology targets the efficiency improvement. Variable speed air conditioners are considered as high-end products, which have a higher price than the normal products. The consumers are willing to pay a higher price for the high-end products[13].

Although the price is much higher, the market share of variable speed air conditioners increased from 8.4% in 2007 to 43.8 in 2012 [20]. The manufacturing cost of the variable speed air conditioner is higher than the fixed speed air conditioners, because it put extra controlling equipment on. However, it's doubted that the manufacturing cost difference between fixed and variable technologies is as high as up to more than 40%. A further study to disclose the manufacturing cost between those two technologies needs to be conducted.

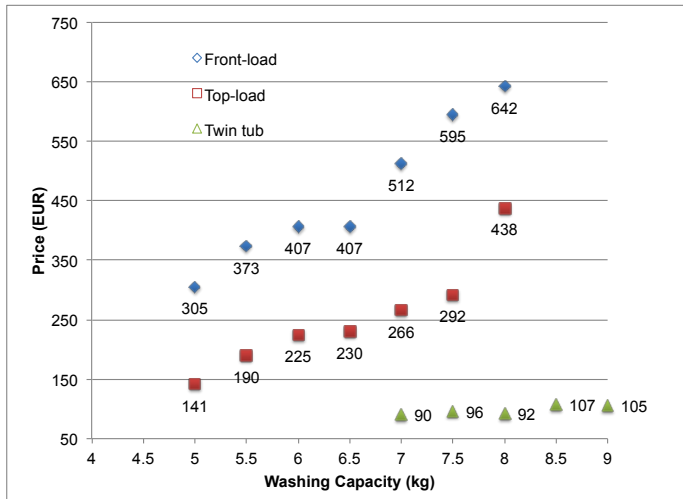


Figure 2 Washing capacity, technology versus price of washing machines
*n=1316

Comparing with the front-load and top-load washing machines in figure 2, which are generally automatically programmed machines, the twin tub washing machines are semi-automatic technologies. It's the technology that needs to be eliminated from the market. The price of the twin tub washing machines is much lower than the other two technologies.

Under the same washing capacity, the price of the front-load washing machine is much higher than the top-load washing machine, which is about 80% higher on average. The top-load washing machine is traditional technology and has existed for a very long time. The front-load washing machine was introduced into China in middle 1990s. According to the testing method and energy efficiency standard - GB 12021.4-2004 [14], front-load washing machines only have better performance in the water efficiency, but it can't lead to the 80% price differences. The manufacturers and retailers usually don't take the energy saving as the selling points for the front-load washing machines. The washing quality is usually taken as the selling point [13]. The front-load washing machine is also considered as the high-end product.

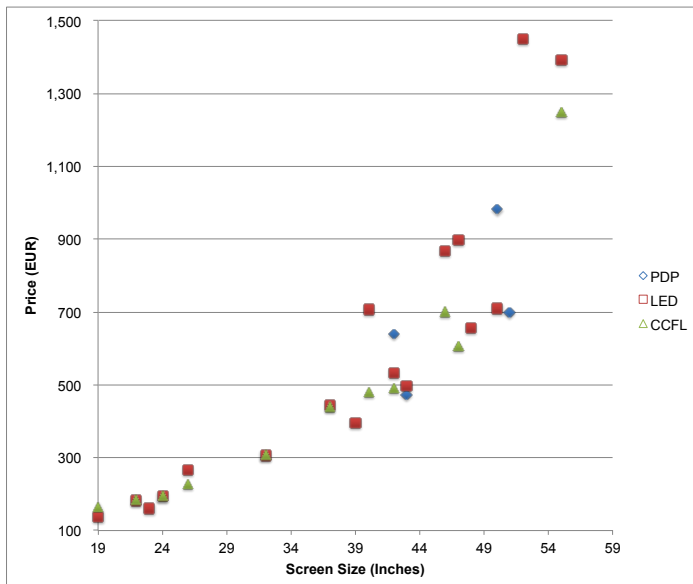


Figure 3 Screen size, technology versus price of flat-panel TVs
*n=2307

**PDP - Plasma Display Flat-panel TV, LCD - Liquid Crystal Display, CCFL - Cold Cathode Fluorescent Lamp, LED - Light Emitting Diode

The PDP and LCD technologies have principle differences in the image display. The absolute energy consumption of PDP TVs for similar size models is much higher than the LCD TVs. However, those two technologies are set different efficiency requirements in the energy efficiency standard - GB 24850-2010 [15]. The energy efficiency index (EEI) for PDP TV is improved by a correction factor and the requirement for PDP tier 1 (1.2) is 0.2 less than tier 1 requirement of the LCD TVs (1.4). The energy efficiency standard helps the PDP panel TVs to get a better energy efficiency tier. The energy label of the flat-panel TV only discloses the efficiency tiers and EEI of the TVs. The consumers can't get the power information from the TV energy label. Although the LCD TVs have much better energy efficiency performance, the price differences between the technologies is not clear. It's advertised by the manufacturers and retailers that the PDP TVs have better image quality and dynamic range.

LCD TVs dominate the market now [16] and the price of the LCD TVs has continued to decreased in recent years [16]. Under the LCD technology, there are two backlight technologies - CCFL and LED. They are regulated by the same energy efficiency requirements. CCFL launched the market for the LCD TVs with LED following and then taking the bigger market share [16]. However, the price differences between CCFL and LED TVs is quite small and can be considered as the same price bracket. About 75% of consumers thought the LED technology had better energy efficiency [17], which is ranked at the second of all advantages of the LED technology. The first ranked advantage of LED TVs is that they have thinner shape.

The market development and competence has huge effects on the price of the LCD TVs. In 2007, the average price of a 42 inch LCD TV was more than 1300 Euros [18], the price was reduced to around 500 Euros in 2012 when LCD TVs dominated the market.

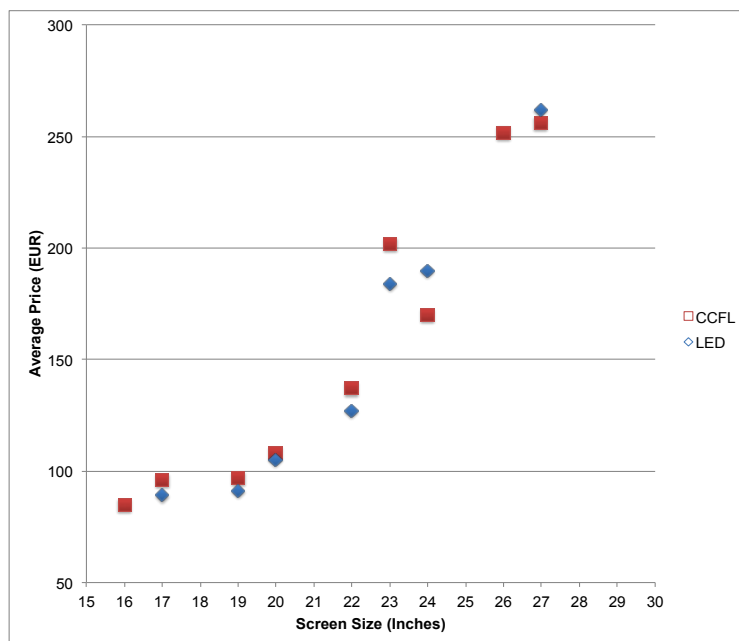


Figure 4 Screen size, technology versus price of LCD monitors
*n=652

For the LCD monitors, the price difference between the two technologies is also very small.

For the LCD displays (flat-panel TV and monitor) the price of the LED displays was indeed higher than the CCFL displays [17], when LED displays were just put into the market. Due to the rapid market development, the market share of the LED technology caught up with the CCFL, which lead to the decrease in price.

The technology has obvious impacts on the price, which is not a surprise. The new technologies bring not only energy efficiency improvement but also other advantages compared to the old technologies. For air conditioners and washing machines, the new technology has a much higher price than the old ones and the new technologies are still

struggling to take more market shares. For LCD displays, the new LED technology has already taken significant market shares, which lead to the decrease of the price. The products have a differing level of importance in terms of energy saving ability for the consumers. Some products are considered more important in energy saving than the others, such as the air conditioner, which is recognized by 53% of consumers as the most important product [8]. It might be the reason that the price of variable speed air conditioners is much higher than the fixed speed ones, because the variable speed air conditioner is targeting for improving the energy efficiency of the air conditioners.

Impacts of the capacity on the retail price

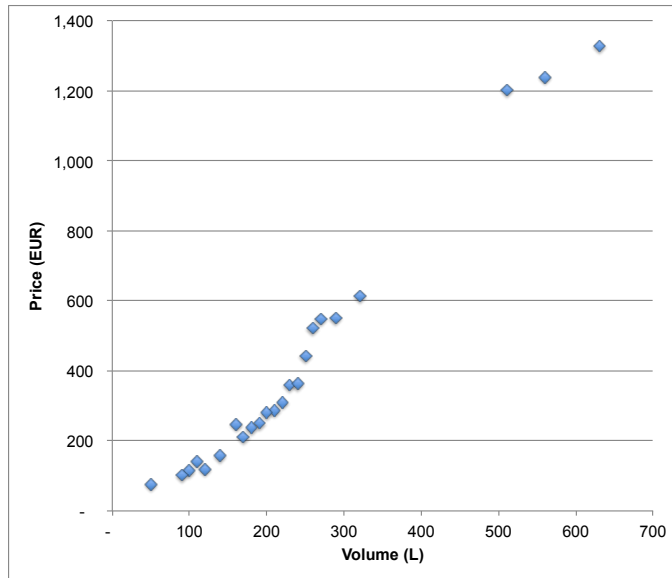


Figure 5 Volume versus price of refrigerators
*n=1667

Figure 1 to 5 show clearly that the price has very close correlation with the capacities (cooling capacity, size and volume, etc), in which the price maintains a linear increase with the capacity. The regression analysis results in table 1 also show that the price has close correlation with the capacity under the same technology.

Table 1 Regression analysis of capacity and price

Product	Technology	R2
Air Conditioner	Fixed	0.472
	Variable	0.635
Washing Machine	Front-load	0.365
	Top-load	0.353
	Twin tub	0.608
Flat-Panel TV	PDP	0.493
	LED	0.361
	CCFL	0.414
Monitor	LED	0.509
	CCFL	0.280
Refrigerator		0.571
Rice Cooker		0.004

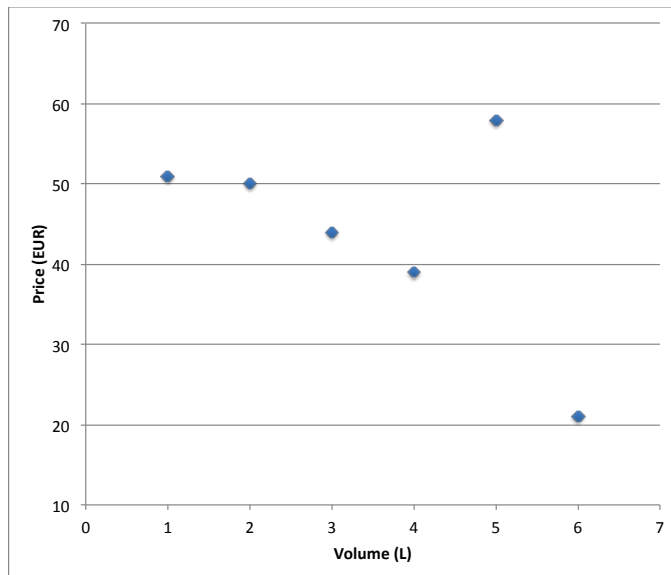


Figure 6 Volume versus price of rice cookers

*n=1276

However, there is no obvious pattern in figure 6 for the rice cookers. The price decreases with the volume range from 1 to 4 liters, and then the price jumps and falls without any regular pattern. The average of 5 liters rice cookers is much higher than the other liters. The number of models at 5 liters is 324. Under the same volume, the price differences are so huge that it can be said the volume has very limited impact on the price. The average price of all rice cookers is about 47 Euros, but the standard deviation is high, up to 70 Euros. There are very cheap rice cookers for basic cooking and there are extremely expensive rice cookers with complicated functions for multiple cooking. There are also a lot of imported rice cookers whose prices are much higher than domestic products.

As the price increases with the capacity, the subsidy criteria are increased with the capacity in the rebate programs. The higher the capacity, the higher the subsidy. However, the subsidy should not be awarded to the oversized products, because the ratio between the subsidy and retail price decreases with the capacity. The low subsidy ratio has limited impacts on switching the consumer's preference towards the high efficiency products. It might also encourage the consumers to buy larger products, which they don't need. No matter what, the efficiency changes with the capacity, the absolute energy consumption increases with the capacity [3].

Impacts of energy efficiency tiers on the retail price

Energy efficiency tiers play key roles in the policies. Tier 3 or 5 are the mandatory minimum requirements for products to access the market. Tier 2 and 1 are generally endorsement requirements for the energy efficient product certification and incentive policies. Energy efficiency tiers also have impacts on the product prices.

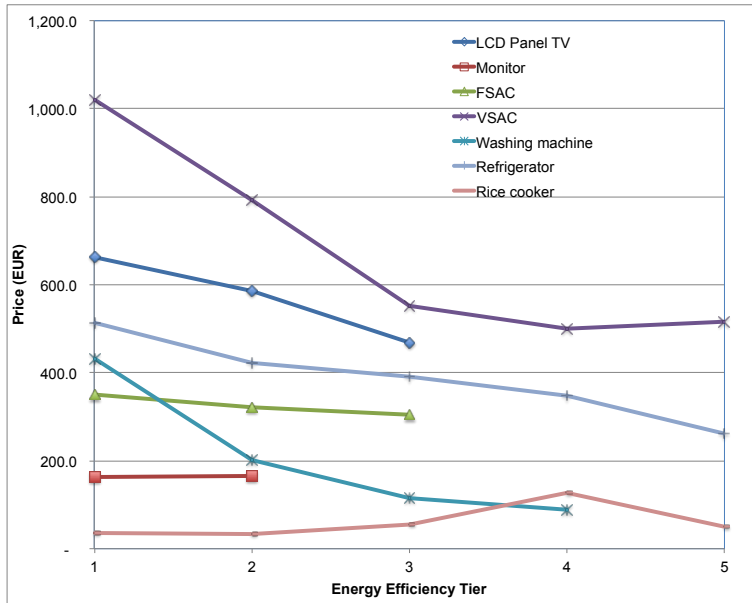


Figure 7 Energy efficiency tiers versus average price of 7 selected products
*n=9847

Figure 7 shows that the price has very close relation to the energy efficiency tiers for 5 products, with the price increasing with better tiers. The similar relation of price and energy efficiency tiers can be observed in Europe [19]. For rice cookers, the price is not related to the energy efficiency tier. Some low tier products even have much higher purchase prices than high efficiency ones. The price of tier 4 is very high, because most of the tier 4 products are the imported multi-functional rice cookers. The quality and other factors play a more important role in the product pricing than the energy efficiency tier.

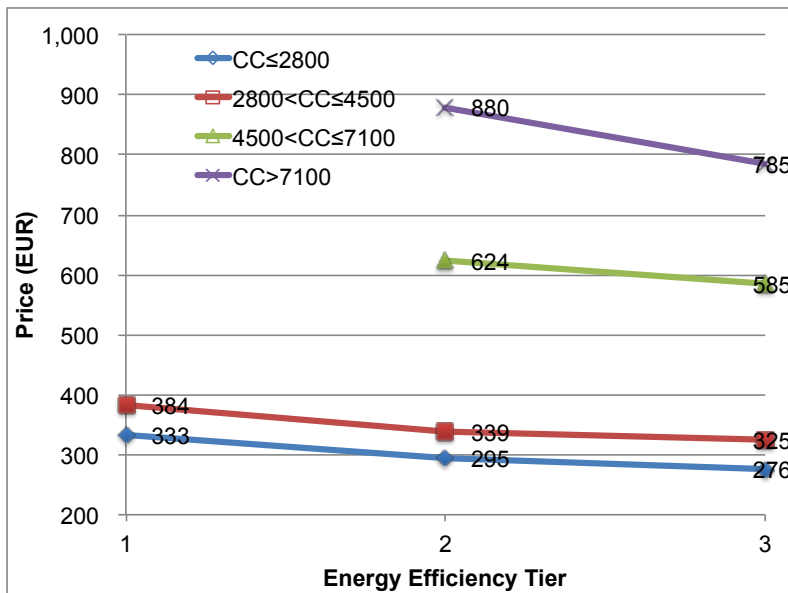


Figure 8 Energy efficiency tier versus price of fixed speed air conditioner
*n=1714

** CC = Cooling Capacity, Unit: W.

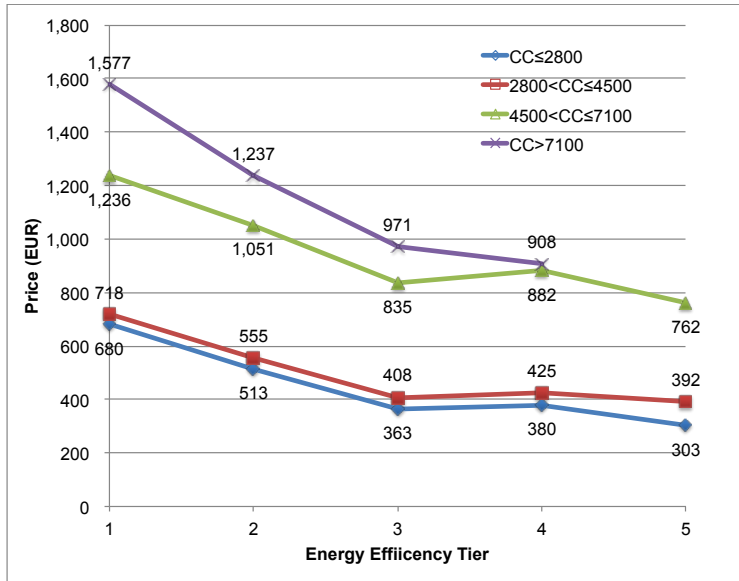


Figure 8 Energy efficiency tier versus price of variable speed air conditioner
*n=915

Generally, the manufacturing cost of the high energy efficient products is higher than the low efficiency ones. For the variable speed air conditioners, the price differences between tier 1, 2 and 3 are so significant that one can deduce that manufacturers and retailers develop their product pricing strategy according to energy efficiency tiers (and not according to the actual added cost of better equipment). The life-cycle cost of the higher tier products is also higher than the lower tier products, which means that the users can get the extra purchasing cost back from the energy saving [20]. Further research on the manufacturing costs, retail price, energy efficiency and market competition should be conducted for those products.

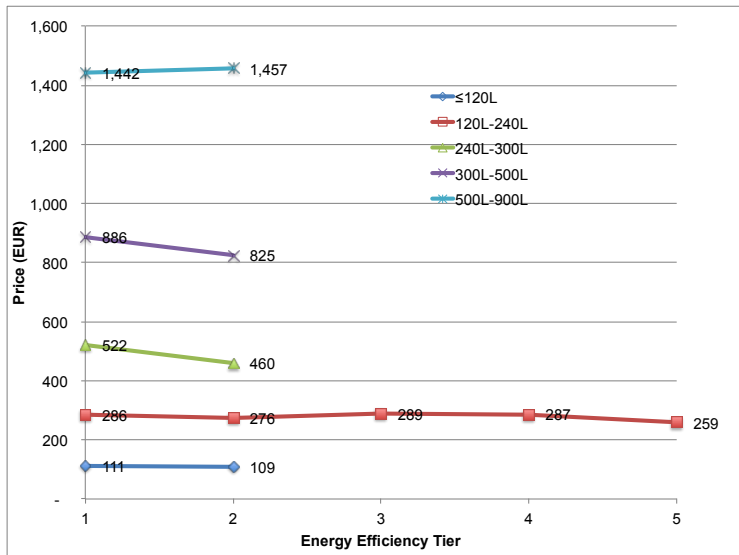


Figure 9 Energy efficiency tier versus price of refrigerators
*n=1667

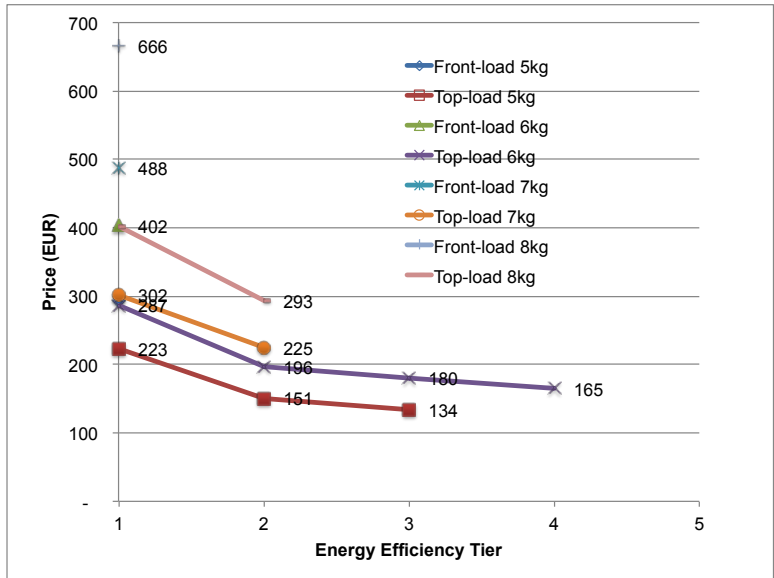


Figure 10 Energy efficiency tier versus price of washing machines
*n=1163

A similar relationship between the energy efficiency tier and price can be found for the refrigerators. In general, the price increase with better tiers. However, for the rice cookers, the price has no correlation with the energy efficiency tiers.

Impacts of energy efficiency indicator on the retail price

The energy label also discloses the energy efficiency indicator information. It provides further information for the consumers to compare the products within the same energy efficiency tier. Because there are too many products, tier 1 products for the refrigerators, washing machines, panel TVs and monitors [3][20], the detailed efficiency indicator information is the only source to distinguish the products. However, more than 58% consumers don't understand the energy efficiency information on the label [8].

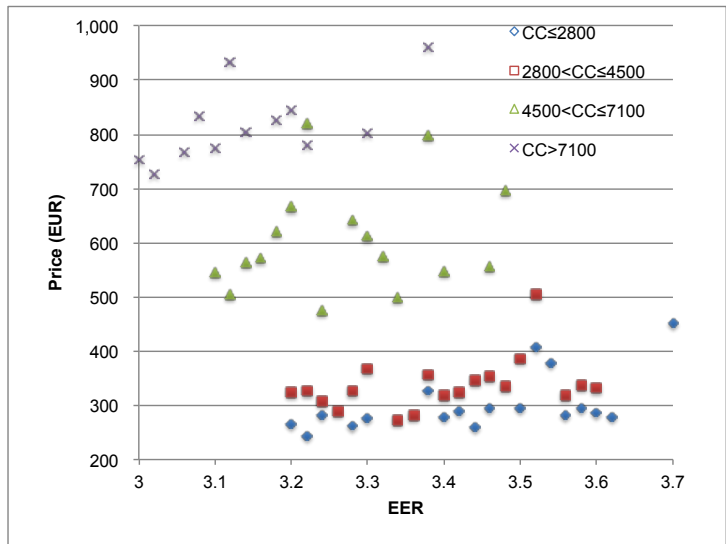


Figure 11 EER versus price at different cooling capacity range of fixed speed air conditioner

*n=1714

** EER : Energy efficiency ratio

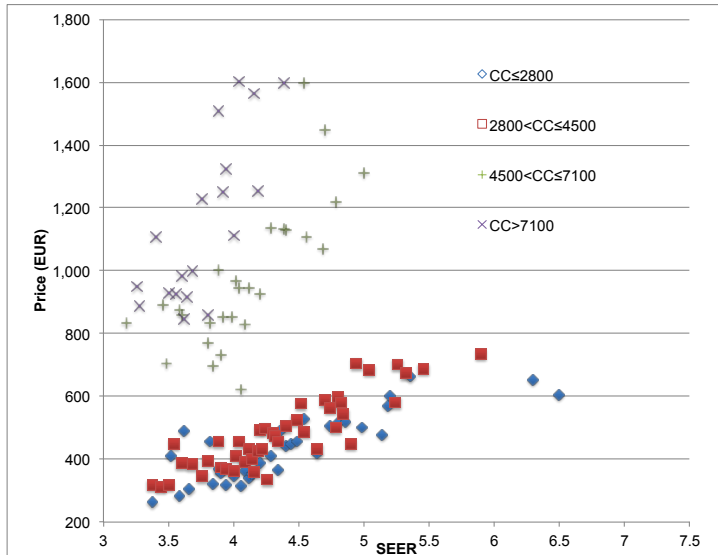


Figure 12 SEER versus price at different cooling capacity range of variable speed air conditioner

*n=915

** SEER: Seasonal energy efficiency ratio

For the fixed speed air conditioner, the price has a clear changing pattern with the EER. However, for the variable speed air conditioner, the price increases with the increase of SEER in four categories. The fixed speed air conditioner has the scale of 3 energy efficiency tiers, while the variable speed air conditioner has the scale of 5 energy efficiency tiers. The tiers might help to regulate the price with the SEER. The consumers also pay more attention to the energy efficiency of air conditioners [8].

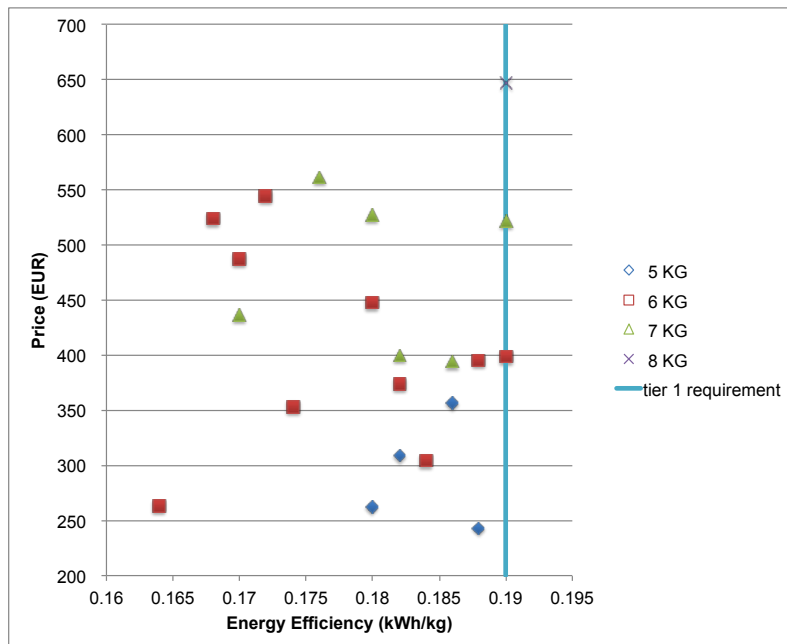


Figure 13 Energy efficiency versus price at different washing capacities of front-load washing machine

*n=428

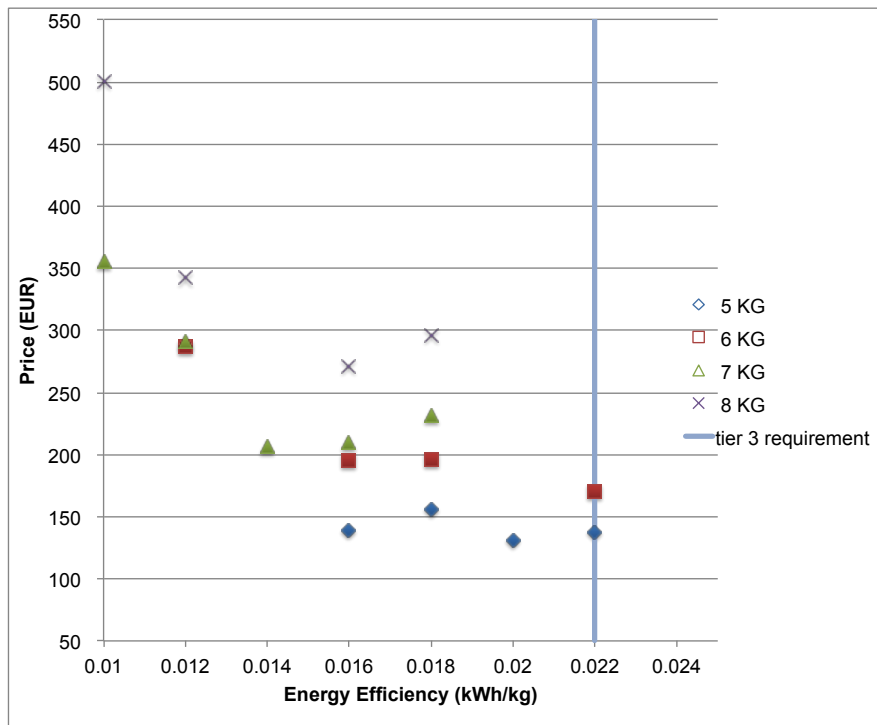


Figure 14 Energy efficiency versus price at different washing capacities of top-load washing machines

*n=735

All front-load washing machines are labeled under tier 1. In this situation, only detailed energy efficiency indicators could be used. However, no patterns can be observed from Figure 13, which indicates that the efficiency indicator information does not affect the price.

For top-load washing machines, the general pattern is that the price goes down as the energy efficiency decreases. There are 3 energy efficiency tiers for the top-load technologies. The similar phenomenon can be found for the water efficiency of front-load and top-load washing machines.

There are also no patterns between the price and energy efficiency information for the flat-panel TVs and rice cookers.

For most of the products, the energy efficiency indicator information has very limited impact on the price, because it's not easy for normal consumers to understand the technical background of the efficiency. Taking the flat-panel TV for example, the efficiency indicator is named Energy efficiency index (EEI). It's the ratio between luminance and power in principle. However, it's corrected by a factor according to the technologies (LCD and PDP). It can't be expected that the consumers will fully understand what the EEI represents. They can't compare the products according to the EEI. It's well known for them that the lower of the energy efficiency tier, the better the efficiency. However, for most of the energy efficiency indicators, the higher the value, the better the efficiency.

Conclusion and recommendations

1. The technology has great impacts on the price. The new technologies bring new improvements, not only the energy efficiency, but also other features such as user experiences and shape, etc. All the improvements are jointly affecting the price. Generally, the new technology has a higher price than the older technology. The price of the new technology goes down when the new technology takes a bigger market share. The rebate program should help the technology with the highest energy saving potential to penetrate the market, and the subsidy should not be awarded to the low efficient technologies, such as

PDP TVs. This will accelerate the progress of the market transformation towards higher efficiency.

2. For most of the products, the price increases with the capacity. The subsidy criteria also increase with the capacity in the rebate programs. However, the absolute energy consumption increases with capacity accordingly. The subsidy for the large products might encourage the consumers to buy over-sized products they don't require. Not only the efficiency, but also the sufficiency should be taken into consideration in the rebate programs.

3. The price has close relationship with the energy efficiency tiers for most of the products, which increases with the better tiers. It's certain that the manufacturing cost of the high efficiency products is higher than normal products. However, for some products such as variable speed air conditioners, the price differences among the tiers is so high that it is possible to say that the manufacturers or retailers boost the price according to the energy efficiency tier.

4. Except for air conditioners, the price has low relationship with the energy efficiency information. The consumers lack in knowledge to fully understand the energy efficiency indicator. The public education of the energy label and reform of the energy label are needed.

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