Structured Retail Products and the Equity Term Structure [*]

Sarita Bunsupha [†] and Gordon Liao [‡]

November 21, 2018

PRELIMINARY

Abstract

Recent empirical evidence of a downward-sloping term structure of equity risk premium challenges many leading asset pricing models. This paper reassesses empirical facts using different sources of dividend data across a number of major equity indices and proposes a demand-based asset pricing model as an alternative theory. We argue that localized market participation in financial activities partially explains the term structure and the time variation of implied equity dividends. In particular, equity derivative products are major sources of dividend supply shocks, resulting in the variation in implied dividends across time and across equity indices. Using issuance data, we show that the implied dividend term structures for major equity indices respond to structural flows from equity structured product issuance.

JEL Classification: G12, G23
Keywords: equity term structure, equity derivative products, demand-based asset pricing

---

[†]*Corresponding author* sbunsupha@fas.harvard.edu. Department of Economics, Harvard University, Cambridge, MA 02138.

[‡]gliao@post.harvard.edu. Cambridge Square Capital, Boston, USA. This work was done during his PhD at Harvard Business School, Cambridge, MA 02138.

1 Introduction

Bonds with different maturities have varying yields. Similarly, risky assets do not have flat term structure but also have returns varying with time horizon. This paper reassesses empirical facts about equity term structure using finite-horizon equity-linked instruments to construct equity price, yield, and return term structures. We find that there is heterogeneity in the shape and slope of risk term structure across indices and across time. We then propose the market specialization story that can explain variations in prices and returns of assets with different maturities. We argue that exogenous dividend supplies from structured product issuances impact the pricing of dividends. Such dividend supply shocks explain the variation of implied dividends across time and across equity indices.

The literature on the term structure of discount rates has attracted a lot of attention recently. Van Binsbergen et al. (2012) calculate returns and volatilities of S&P 500 dividend claims using S&P index options and find that short-term dividends have both higher returns and higher volatilities than S&P 500 index itself. Boguth et al. (2012) argue that small pricing frictions such as bid-ask bounces can bias returns upward but nonetheless agree that the strong upward sloping term structure is inconsistent with empirical evidence on equity return term structure.[1] Van Binsbergen et al. (2013) and Van Binsbergen and Koijen (2017) use a new dataset of dividend futures and reach a similar conclusion that expected returns of short-term dividends are indeed much higher than those of indices. Gormsen (2017) focuses on the time variation of the equity term structure and finds that the term structure of equity returns is counter-cyclical: it tends to be downward sloping in good times.

Outside of equity, Lustig et al. (2014) find that average returns to currency carry trade also decrease with the maturity. Backus et al. (2018) offer complementary evidence on the average log excess returns across different horizons of a diverse set of assets such as foreign-currency bonds, inflation-protected bonds, and dividend yields. They find that excess log returns decline with the horizon. Giglio et al. (2014) and Giglio et al. (2015) exploit a feature of leaseholds versus freeholds in housing markets in England and Singapore and find low long-run risk premia.

The downward-sloping risky term structure is inconsistent with most macro-finance models. Stocks are intertemporally risky in Bansal and Yaron (2004)'s long-run risk model, resulting in upward-sloping equity term structure. External habit formation, as in Campbell and Cochrane (1999), features the persistent increase in the price of consumption risk. Long-maturity assets are thus riskier and demand higher risk premia. Enhancing the rare

---

[1]Indeed, Bansal et al. (2017) incorporate bid-ask spreads and trading volumes and show that the measured equity term structure could be upward sloping once accounting for illiquidity.

disaster model with a time-varying disaster probability and a time-varying disaster magnitude, as in Gabaix (2012), can at most generate flat term structure of risk premia.

Examples of existing models that can generate downward sloping term structure of risk premia are as follow. Lettau and Wachter (2011) use essentially affine term structure model to price risky claims, resulting in flat risk-free term structure and downward-sloping risky term structure. Belo et al. (2015) argue that both the long-run risk model and the habit-formation model can be consistent with downward sloping term structure of expected returns and volatilities with dividend dynamics that generate stationary leverage ratios.

This paper argues that, in order to understand variations in dividend prices, it is necessary to go back to see where demands and supplies of these dividends are from. In our market specialization story, there are two main types of dividend investors: end-users and intermediaries. End-users demand an exogenous amount of structured retail products. These structured retail products issuance generates dividend supply shocks which intermediaries have to bear. With a limited risk-bearing capacity, intermediaries require returns to compensate for their absorption of time-varying dividend supply. During the period in which there are a lot of structured retail product issuance, intermediaries need to absorb a high volume of dividends. As intermediaries have certain risk limits, high dividend supplies will suppress dividend prices, and dividend returns must be high to compensate intermediaries for meeting market demands.

The proposed market specialization story is closely related to existing literature on demand-based asset pricing. Garleanu et al. (2009) propose the demand-based option pricing model and show that demand pressures from the put-call imbalance indeed explain cross-sectional variation in volatility skewness across U.S. equity options. Vayanos and Vila (2009) and Greenwood and Vayanos (2014) use the preferred-habitat model to explain the term structure of riskless returns. Risk-averse intermediaries trade with end clients with strong preferences for specific-maturity bonds driving the price and return variation across different maturity.

In order to evaluate our market segmentation story, we obtain structured product issuance data and use it as a proxy of dividend supply. We then test whether dividend supply risk can explain some variation in equity term structure.

The paper is structured as follows. Section 2 discusses different ways of constructing equity term structures and provides empirical patterns of equity term structure across different indices. Then, we move on to provide an overview of equity derivative markets and discuss their relation to dividend markets in Section 3. Section 4 proposes the supply-based dividend pricing model along with its implications. We discuss empirical strategies

used in verifying our proposed mechanism along with results from structured product issuance data in Section 5. We conclude our findings in Section 6.

2 The Equity Term Structure

The equity return term structure is the relationship between returns from holding T-maturity assets and time to maturity T. Stocks and indices are infinitely-lived assets. Holders of such assets are entitled to any dividends paid in the future. One way to construct T-maturity assets is to look at assets that paid dividends only up to a certain period in the future. That is, dividends are one of the most straightforward instruments that can be used to calculate equity term structures.

2.1 The Pricing of T-Maturity Assets

No arbitrage assumption implies that the price of the T-maturity assets linked to a specific underlying must be equal to the price of dividends paid up to T periods from now. We discuss different ways used in pricing equity dividends as follows.

2.1.1 Spots versus Forwards or Futures

In order to be entitled to dividends paid, investors must pay spot prices to own shares of related underlyings. Forwards and futures are contracts that bind the buyers to buy a certain quantity of a security at a specified price at a specified date in the future. Holding a long position on forwards or futures gives no exposure to dividends paid in between. On the other hand, buyers of forwards or futures contract do not have to pay the full price of the security in advance. We can deduce dividend exposures from trading spots versus forwards or futures by hedging out interest rates (and any associated repurchase costs).

Formally, let $P_{t,T}$ be the price of T-maturity asset at time t; S_t be the stock price at time t; $F_{t,T}$ be the forward price at time t for an exchange at time $t + T$; $r_{t,T}$ be the per-period interest rate from time t to $t + T$; and $\delta_{t,T}$ be the dividend yield of dividends paid between time t and $t + T$. We have the following equations:

$$F_{t,T} = S_t \cdot e^{(r_{t,T} - \delta_{t,T}) \cdot T} \tag{1}$$

$$\delta_{t,T} = r_{t,T} - \frac{\log(\frac{F_{t,T}}{S_t})}{T} \tag{2}$$

$$P_{t,T} = \delta_{t,T} \cdot S \cdot T. \tag{3}$$

Equation (1) comes directly from the no-arbitrage condition. It should cost investors exactly the same whether they buy securities now or enter in the forward agreement to buy in the future. As long as the forward is priced correctly, equation (1) should hold.

Rearranging equation (1) yields equation (2). That is, dividend yields can be implied from spots versus forwards after filtering out the interest rate component.

We can then construct the price of T-maturity asset from dividend yields using equation (3).

2.1.2 Synthetic Forwards

Most equity markets only quote and trade near-dated futures with mostly quarterly expiries. Constructing synthetic forwards from options allows for greater coverages with a bigger range of maturities. Specifically, investors can create synthetic long forwards by buying European calls and selling European puts. Formally, let $c_{t,T}$ be the price of the at-the-money call expiring at time $t + T$; p_t be the price of the at-the-money put expiring at time $t + T$; D_i be the dividend payable at time $t + i$; and N be the biggest number such that $t_N \leq T$ when t_i is weakly increasing in i.[2] The put-call parity yields

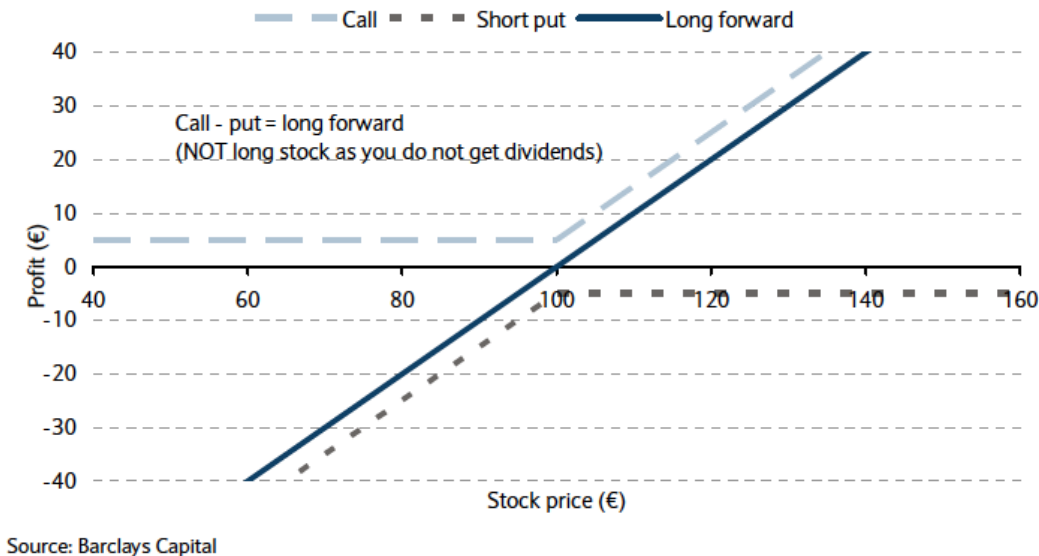$$(c_{t,T} - p_{t,T}) \cdot e^{(r_{t,T} \cdot T)} = F_{t,T} - S_t. \tag{4}$$

Figure 1: Put-Call Parity

Source: Barclays Capital

---

[2] At-the-money options have the strike price that is equal to the current spot price S_t.

Figure 1 illustrates how a combination of long calls and short puts is equivalent to being long forwards.

The relationship in equation (4) allows us to derive the T-maturity dividend yields and T-maturity asset price accordingly.

2.1.3 Dividend Swaps

Dividend swaps are trading instruments that give investors pure dividend risk. Such instruments were created back in the late 1990s first with index dividend swaps. Dividend swaps on single stocks emerged around the year 2000.

The buyer of a dividend swap agrees to pay a fixed amount (called the fixed leg) in exchange for the sum of all qualifying dividends paid during the life of the swap. Such sum is called the floating leg.[3]

Let $SW_{t,i}$ be the price of the dividend swap (i.e. the fixed leg) at the time t of cumulative dividend points payable between time $t + i - 1$ and time $t + i$. That is, buying such dividend swap yields the buyer a net profit of whatever dividends accrued from time $t + i - 1$ to time $t + i$ less the cost that is equal to the fixed leg. We can then calculate the price of T-maturity asset by summing over the price of dividends paid between time t to time $t + T$, i.e.

$$P_{t,T} = \sum_{i=1}^{T} SW_{t,i}.$$

2.1.4 Dividend Futures

Dividend futures, like dividend swaps, expose investors only to dividend risk. Dividend futures were created in 2008 as listed alternatives to dividend swaps (which are traded over the counter). The first dividend futures were linked to the SX5E index. European dividend futures entered the markets in 2009. SX5E single stocks and Japanese dividend futures followed in 2010.

Again, let $F_{t,i}^{d}$ be the price (the fixed leg) at time t of cumulative dividend points payable between time $t + i - 1$ and $t + i$. It follows that

$$P_{t,T} = \sum_{i=1}^{T} F_{t,i}^{d}.$$

---

[3]As dividends are summed, the exact ex-date within the period become irrelevant.

Four different ways of pricing *T*-maturity assets have their own pros and cons. Forwards and futures have the most comprehensive data (as both are traded heavily in the markets). However, they have other confounding risks (such as interest rates and repo risk) in addition to dividend exposures. Options have the same advantage and drawback as forwards and futures.

Dividend swaps and dividend futures are ideal instruments to price *T*-maturity assets since both only have direct dividend exposures. However, data on such instruments is less abundant. Dividend swaps are traded over-the-counter with no systematic record keeping. Each trading entity maintains its own records of dividend swap levels. On the other hand, dividend futures are listed in the market and thus are more transparent. However, dividend futures started trading much later. Low liquidity and sparse trades among dividend futures also limit the data availability.

2.2 Data and Methods

Since different ways of pricing *T*-maturity assets have their own pros and cons, this section discusses how the paper conducts an analysis of equity term structure.

2.2.1 Data

We focus on the following equity indices: SX5E Index, UKX Index, SPX Index, NKY Index, KOSPI2 Index, HSI Index, and HSCEI Index.

Bloomberg

We obtain spot prices, index futures, total return index, dividend points, and option data associated with the above indices from Bloomberg. We construct the zero rate curves associated with each index by bootstrapping the yield curve and the interest rate swap curve. We obtain dividend future levels for above indices (except KOSPI2) from the earliest available to January 2017.

Proprietary Option Prices

We obtain the proprietary data from one of the investment banks containing call and put premiums for 3-, 6-, 9-, and 12-month and 2-, 3-, 4-, 5-, 7-year at-the-money options for each index in the list.

Proprietary Dividend Swaps

BNP Paribas kindly provides fixed-maturity dividend swap levels (2005 - 2018 dividend swaps) for SX5E, UKX, SPX, NKY, and HSCEI Index.

Van Binsbergen et al. (2012)

We will compare the construction from 3 different methods (spot versus forwards and futures, synthetic forwards, and dividend swaps and dividend futures) to results from Van Binsbergen et al. (2012).

2.2.2 Methods

Recall that $P_{t,T}$ is the price at time t of dividends paid between time t and $t + T$. Similarly, we denote $P_{t,j,T}$ to be the price at time t of dividends paid between time j and $t + T$. At a given time t, the dividend contract with price t, j, T is called a front-month contract if $j < t$. If $j \geq t$, such contract is not front-month, and the realization of dividends has not yet occurred. Let $R_{t+1,j,T}$ be the simple 1-period return of dividends paid between time j and $t + T$. We then have that

$$R_{t+1,j,T} = \frac{P_{t+1,j,T-1} + D_{t,t+1}}{P_{t,j,T}} - 1, \tag{5}$$

where $D_{t,t+1}$ is the dividends paid between time t and $t + 1$.

The majority of our data has a fixed maturity, i.e. the maturity is December 2018 instead of 6 months from the inception. Let c be the constant maturity of our interest. Suppose that $t + c$ falls in between two dividend contracts with consecutive maturities $t + T_1$ and $t + T_2$ such that $t + T_1 \leq t + c \leq t + T_2$. We calculate the constant maturity c dividend price using the linear interpolation as below:

$$P_{t,c} = F_{t,T_1-1,T_1} + \frac{F_{t,T_2-1,T_2} - F_{t,T_1-1,T_1}}{T_2 - T_1} \cdot (c - T_1). \tag{6}$$

Similarly, we can linearly interpolate and construct the constant maturity dividend return by again looking at the two contracts with consecutive maturities $t + T_1$ and $t + T_2$ such that $t + T_1 \leq t + c \leq t + T_2$. At each valuation date t, the constant maturity c dividend return is equal to:

$$R_{t+1,t,c} = w_1 R_{t+1,T_1-1,T_1} + (1 - w_1) R_{t+1,T_2-1,T_2}, \tag{7}$$

where $w_1 = \frac{T_2-c}{T_2-T_1}$.

2.3 Comparison across Different Methods of the Pricing of T-Maturity Assets

We use the aforementioned data to construct and compare prices of T-maturity assets from different methods: bbk, divfut, equityfut, and opt represent data from Van Binsbergen et al. (2012), the merge data of dividend swaps and dividend futures, spot versus forwards and futures, and synthetic forwards respectively.
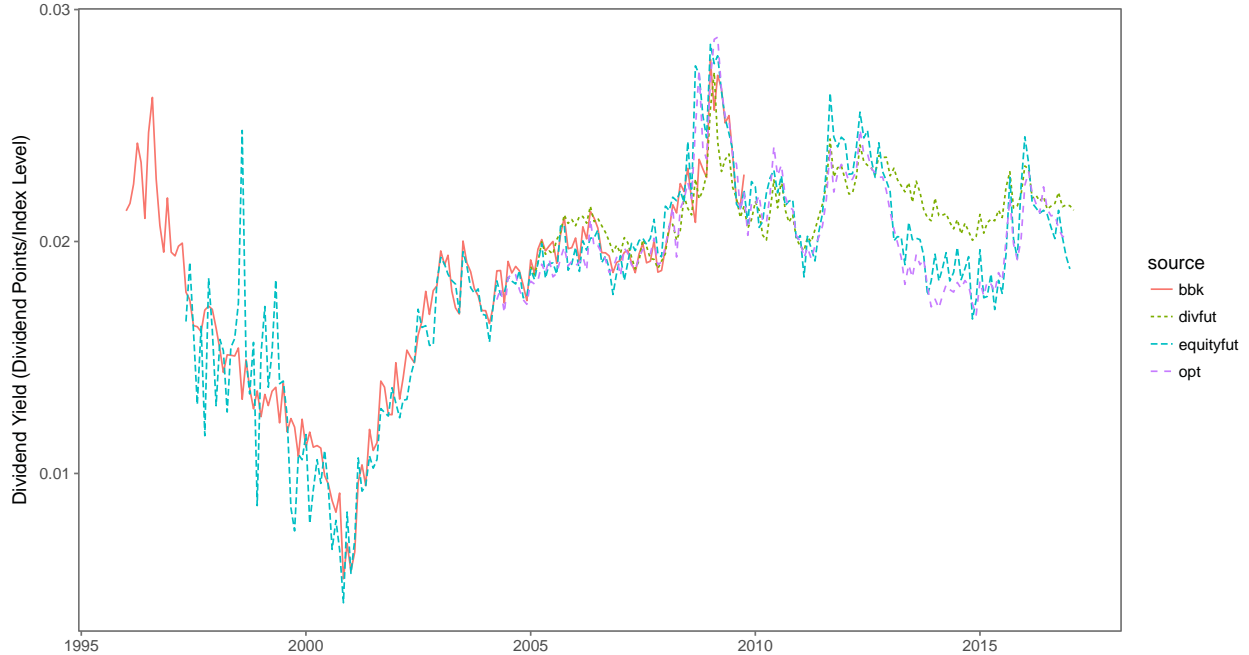

Figure 2: 1-Year Dividend Yield of SPX Index over Time

Figure 2 shows that 1-year dividend prices of S&P 500 Index from different constructing methods are roughly aligned. Appendix A shows the same comparison for different maturities and different indices.

Table 1: Summary Statistics of 1-Year S&P Dividend Yields

	eqfut	opt	divfut	bbk
Mean	0.0212	0.0209	0.0208	0.0210
Stdev	0.0028	0.0028	0.0017	0.0023

Notes: Monthly data from Jan 2005 to Oct 2009 (Maximum period coverage in which all four datasets commonly exist). The total number of observation is 58.

Table 1 displays the mean and the standard deviation of 1-year S&P 500 dividend

yields from different methods during the same period of time. It shows that, during overlapping periods, different constructing methods have in-line dividend prices. That is, different ways of pricing T-maturity assets work equally well, and we may focus on the most comprehensive source.

2.4 T-Maturity Dividend Yields over Time

This section displays T-maturity dividend yields for different equity indices over time when T is equal to 1, 2, 3, and 5 years along with the underlying index level. Dividend prices in this section are constructed from synthetic forwards unless otherwise stated.

Figure 3: T-Maturity Dividend Yield of S&P 500

Figure 3 displays the evolution of 1-, 2-, 3-, and 5-year dividend yields of S&P 500 along with the SPX index level. We observe substantial variation of the dividend yield structure across time. Similar to Van Binsbergen et al. (2013), S&P 500 dividend yield term structure seems to be somewhat pro-cyclical. In this sense, dividend yields in the US markets may partially reflect the expectation of economic growth.

Figure 4: *T*-Maturity Divided Yield of Euro Stoxx 50

Conversely, Figure 4 conveys that the dividend yield term structure stays inverted throughout time for Euro Stoxx 50. 5-year dividend yields are always compressed relative to the front-year yields. Coincidentally, European markets are those with the highest concentration of structured product issuance.
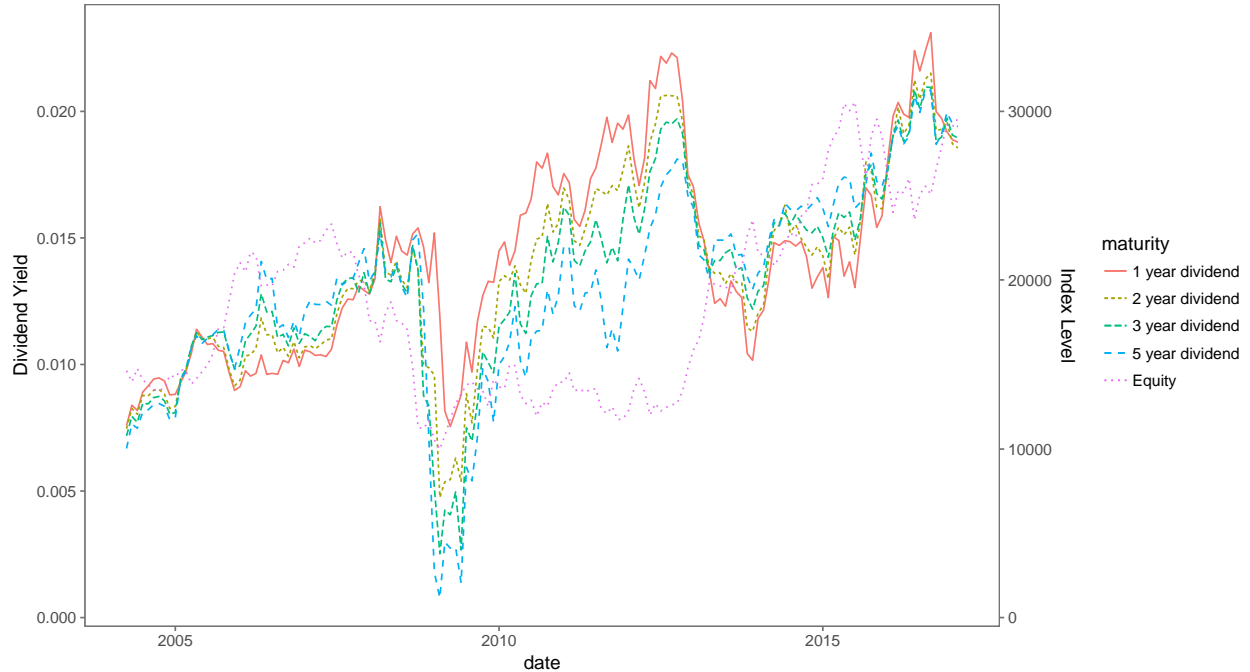
Figure 5: T-Maturity Divided Yield of Nikkei 225

For Japan, figure 5 depicts the variation of the dividend yield term structure across time. Similar to S&P 500, the yield term structure seems to be somewhat pro-cyclical.

Appendix B shows the evolution of the dividend yield term structure over time for other equity indices.

2.5   Cumulative Returns of Assets with Different Maturities

After looking at the price/yield patterns in the previous section, we now turn to an analysis of the dynamics of T-maturity cumulative returns over time. Again, we use synthetic forwards to construct dividend return data unless otherwise specified.
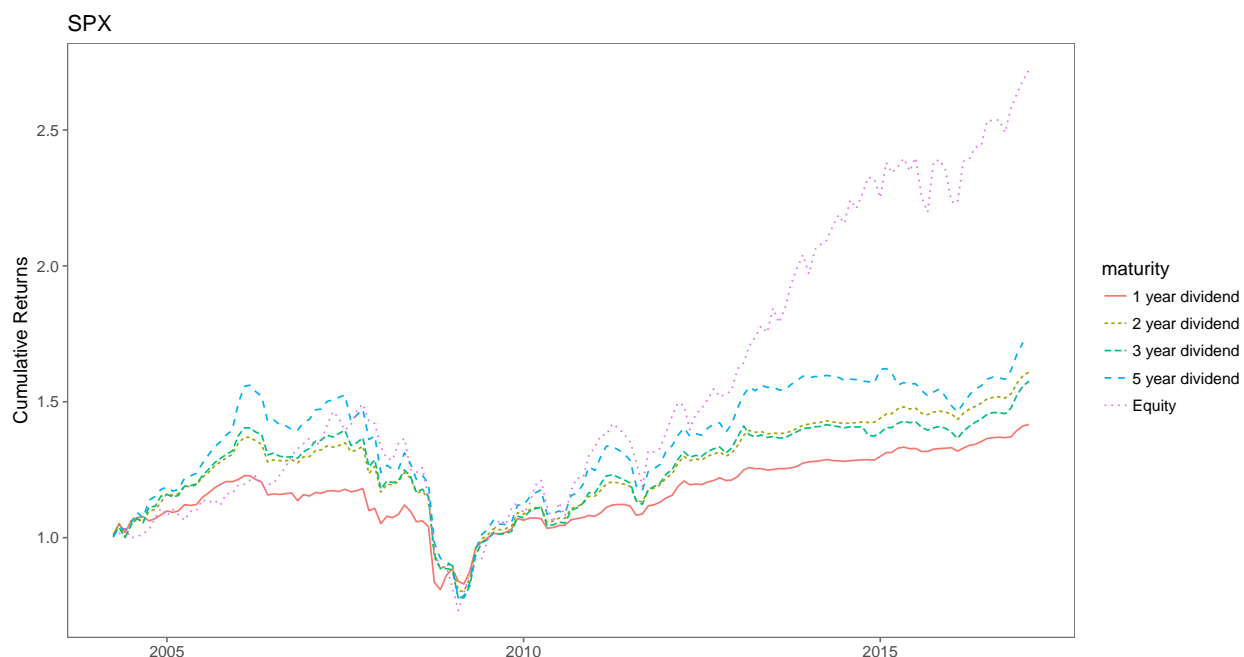
SPX

Figure 6: Cumulative Returns of S&P 500 T-Maturity Asset

Figure 6 illustrates the S&P 500 cumulative return over time. After the 2008 global financial crisis, longer-maturity assets have outperformed shorter-maturity ones.

Some financial analysts argued that one of the contributors to the Great Recession was the increasing complexity of traded financial instruments. In the aftermath of the Great Recession, policy makers required intermediaries to follow stricter guidelines (more trade disclosures and more comprehensive term sheets, etc). Exotic products that were booming suddenly fell out of favor with investors.

Shortly after the crisis, investors' scars were fresh. They shied away from structured product trading. Banks themselves found it more costly to offer customized solutions because of the associated legal risks. All in all, there were not much new trades. The volume of exotic flows stayed low, and most banks merged their exotic trading teams with their flow trading teams as a result.

This observation ties well with our proposed story. During the short period after the financial crisis, the role played by structured retail products was minimal, and the equity return term structure retained its normal upward sloping shape during that time.

SX5E

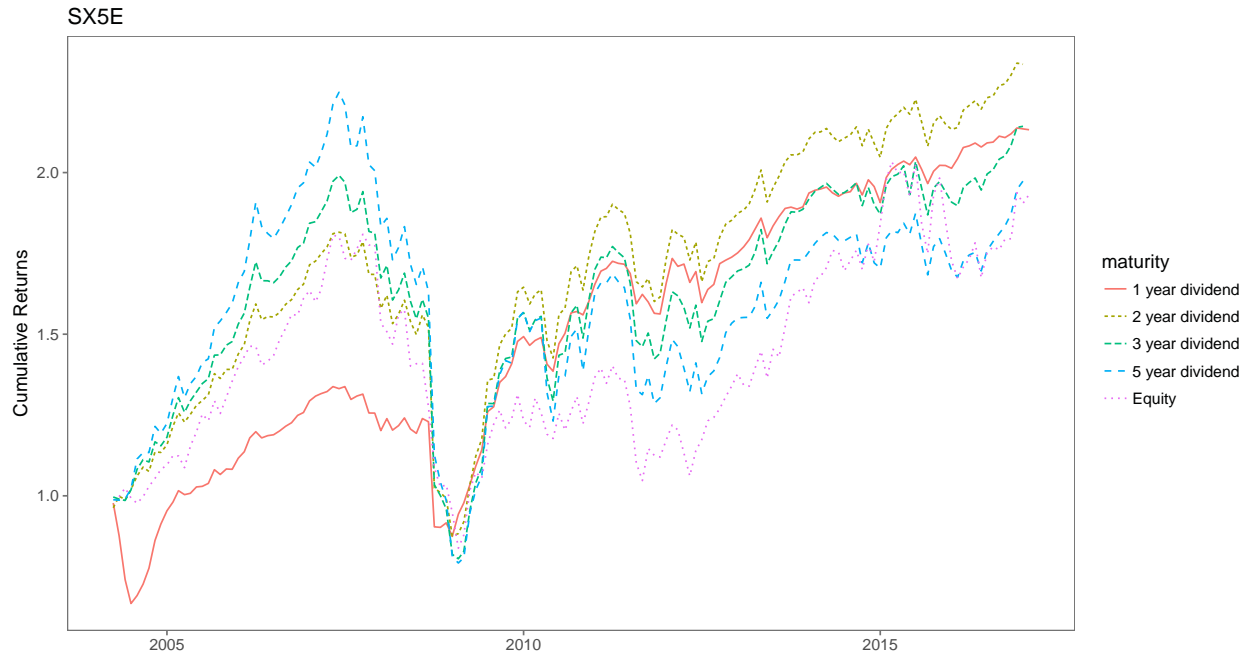Figure 7: Cumulative Returns of Euro Stoxx 50 T-Maturity Asset

However, Figure 7 shows that the Euro Stoxx 50 risky term structure remains inverted most of the time. It is well known by intermediaries that European clients are much more familiar with complex structures than their American counterpart. In fact, European investors often have preferences for structured products as they search for yield.
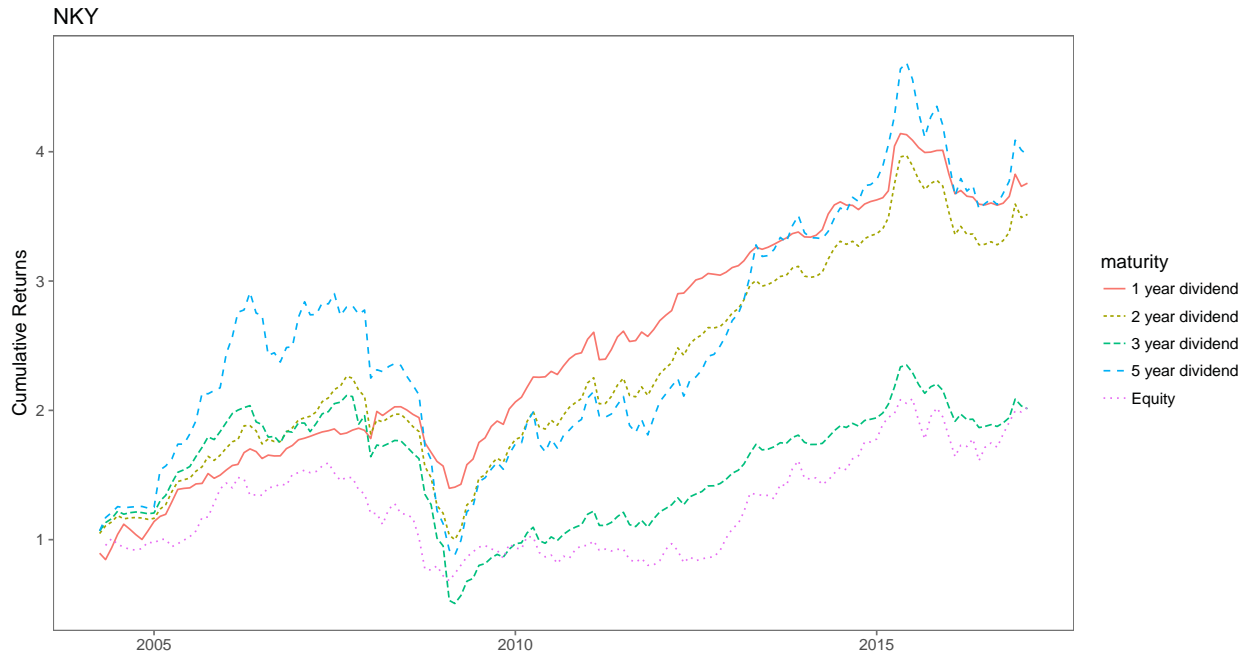
Figure 8: Cumulative Returns of NKY 225 T-Maturity Asset

Similar to the SX5E Index, the Nikkei 225 risky term structure is also almost always downward sloping from Figure 8.

Outside of European markets, the Japanese market is also well known for the trading of structured products. Similar to European investors, Japanese traders also have high appetites for yield enhancers. Intermediaries respond by offering structured notes called "Uridashi" to the markets.

Appendix C shows the same comparison of cumulative returns of T-maturity assets associated with other equity indices.

Cumulative returns of different equity indices reflect that the risky return term structure varies not only with time but also with underlying equities. While cumulative returns of S&P 500-linked assets increase with maturity, the same does not hold for other European and Asian indices.

The patterns of equity return term structure are somewhat related to the structured product issuance. During the time when demands for exotic structures remain muted, longer-maturity assets earn higher returns. The risky return term structure tends to be more inverted in the markets where structured products are popular (such as European and Japanese markets). We will establish the relationship between structured product issuance and the risky term structure formally in Section 5.

2.6 Properties of T-Maturity Asset Returns

2.6.1 Summary Statistics of Returns

Table 2: Summary Statistics of T-Maturity Asset Returns

Maturity in Year	1	2	3	5	∞
SPX					
Mean (%)	0.5648	0.6848	0.6606	0.7041	0.7286
Stdev (%)	3.1988	3.6528	3.7766	4.0388	4.0111
Sharpe Ratio	0.1765	0.1875	0.1749	0.1743	0.1817
SX5E					
Mean (%)	0.5042	0.8279	0.8432	1.0706	0.5421
Stdev (%)	8.7567	4.5229	4.9631	6.0378	4.8796
Sharpe Ratio	0.0576	0.1830	0.1699	0.1773	0.1111
NKY					
Mean (%)	1.389	1.8059	2.7967	5.27	0.6128
Stdev (%)	9.6769	9.9611	19.8897	41.2723	5.6543
Sharpe Ratio	0.1436	0.1813	0.1406	0.1279	0.1083

Notes: Monthly data from Apr 2004 to Jan 2017 using the synthetic forward method. The total number of observation per index is 154.

Table 2 summarizes the mean, the standard deviation, and the sharpe ratio of the 1-, 2-, 3-, and 5-year asset returns along with the associated equity returns. The mean return and the sharpe ratio rise almost monotonically in maturity for S&P 500. On the other hand, Euro Stoxx 50 and Nikkei 225 asset returns are higher with higher sharpe ratio for shorter-maturity assets. Table 7 in Appendix D exhibits properties of T-maturity asset returns for other indices including UKX, KOSPI2, HSI, and HSCEI Index.

2.6.2 Alpha and Beta of Excess Returns

This section looks at the correlation of T-maturity excess returns with market excess returns for each underlying index.

From Table 3, short-dated assets have low beta. Near-end dividend yields are partially determined by announced dividends along with analyst forecasts, and their returns do

Table 3: Regression of Excess Returns on Market Excess Returns

Maturity in Year	1	2	3	5
SPX				
Alpha	0.0031	0.0031	0.0025	0.0024
	(1.3879)	(1.4154)	(1.1026)	(0.9988)
Beta	0.1764	0.3711**	0.4074**	0.4765***
	(1.9426)	(2.8241)	(2.9379)	(3.7704)
R^2	0.0491	0.1660	0.1873	0.2240
SX5E				
Alpha	0.0028	0.0051	0.0048	0.0062
	(0.4095)	(1.9348)	(1.5343)	(1.7720)
Beta	0.2473*	0.5057***	0.6372***	0.7873***
	(2.1797)	(7.3649)	(7.6661)	(8.4725)
R^2	0.0190	0.2991	0.3913	0.4034
NKY				
Alpha	0.0135*	0.0138	0.0217	0.0437
	(2.1717)	(1.6770)	(1.5013)	(1.4790)
Beta	0.1545	0.6351**	0.9800**	1.5190*
	(0.8371)	(3.2085)	(2.8522)	(2.1257)
R^2	0.0082	0.1294	0.0773	0.0431

Notes: Monthly data during Apr 2004 to Jan 2017 from the synthetic forward method. The total number of observation per index is 154. t statistics using Newey-West standard error in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

not vary much with equity returns. Assets with longer maturities rely more on the long-term expectations. For S&P 500, Euro Stoxx 50, and Nikkei 225, the beta of assets increase with their maturities. There is no prominent excess alpha except for 1-year NKY [4].

3 Equity Derivative Markets

Section 2 discussed empirical facts about equity term structure. As briefly mentioned, equity return term structure appears to be more inverted in markets with more structured product issuances or during the time when the total issuance is higher.

---

[4]Table 8 in Appendix D shows the regression results for UKX, KOSPI2, HSI, and HSCEI.

We discuss equity derivative markets and their potential relationship to the equity term structure in this section.

3.1 Three Main Types of Instruments

There are three main products tradable in the equity derivative markets: forwards, vanilla options, and exotic options. Trading desks in typical investment banks are divided according to who is responsible for trading which products among the three.

The delta1 trading desk mainly covers any instrument with delta of 1 (Delta is the sensitivity of an instrument's price to the spot price of underlying assets). Products going to the trading book of this group include forwards, futures, baskets of stocks, equity swaps, and dividend swaps and futures.

The flow trading desk has traders who are responsible for option market-making, the pricing of vanilla options, and warrant market-making. Instruments going to the trading book of this group involve mainly vanilla calls and puts.

The exotic trading desk covers everything else. Traders in this group focus on the pricing of exotic options ranging from light exotic to heavy exotic. Instruments going to the risk book of this group include structured retail products and more customized solution-based structures.

Typically, these three trading desks in the equity derivative trading group maintain separate trading books and have divided risk management systems. With the decline in the volume of non-vanilla products, there has been an increasing trend in combining the flow and exotic trading desks.

For the purpose of this paper, we divide the players in equity derivative markets into two types: intermediaries (investment banks, market makers, etc) and end-users (hedge funds, retailers, etc). Typical instruments traded by institutional clients (hedge funds) are over-the-counter (OTC) and listed options, while those traded by retail clients include structured products and warrants. We do not model end-user investment decisions and take their demands as being exogenous.

Intermediaries in our paper have limited risk-bearing capacities. Their main function is to price all tradable instruments.

3.2 Dividends and Equity Derivatives

There are many factors affecting the price of equity derivatives such as volatility curve, dividend curve, interest rate curve, etc.

This paper focuses on the structured retail products (SRP) because vanilla OTC or listed options are usually of shorter maturities with lower dividend risk. On the other hand, structured retail products normally have long maturities, and their pricings are decently sensitive to dividend exposure.

End users often long calls to get asymmetric upside exposure or short puts from buying reverse convertibles (autocallables).[5] Performance of instruments is almost always given on a price return index and a total return index. As intermediaries short forward exposures from being long calls and short puts, they hedge by buying equities and become net long dividends.

Autocallables (reverse convertible securities) first gained popularity in Japan around 1990s, as a way to enhance yields. Investors use structured notes to sell insurance (by selling puts) to the markets. Such notes are designed to provide investors with higher yields under a mechanism that is similar to that of bonds. As the price of underlying securities falls, the yield on the product rises. However, if the market falls too much, the product converts from a fixed income to an equity.

There are also other types of structured products tradable in the markets. The vast majority of structured products are saving products and consequently involve investors wanting to long exposure to equity markets at some future date. These investors' long forward exposure leaves banks with the short forward exposure.

To hedge the short forward position, banks would long cash equity and subsequently become long dividends. Banks can offload their long dividend exposure by selling dividend swaps to institutional investors. That is, the demand of structured retail products leave some structural imbalances in dividend markets. In particular, higher structured product demands lead to a bigger supply of dividends, suppressing dividend strips' prices and generating excess dividend returns.

3.3 Dividend Markets

Trading spot versus forwards/futures and trading options are two indirect ways of getting the dividend exposure. The creation of pure dividend instruments emerged in the late 1990s. Dividend swaps were originally created by JP Morgan as a way to offload dividend risks that dealers hold from selling equity-linked structured notes.

Dividend futures were later created as listed alternatives to OTC dividend swaps. The first dividend futures started trading in 2008 with Euro Stoxx 50 market, which is the world's biggest structured product markets. Dividend futures linked to the Japanese in-

---

[5]A sample term sheet is in Appendix **??**.

dex and the US index were subsequently created in 2010 and 2015, respectively.

Primary users of listed dividends or any dividend derivatives are exotic trading desks, as they issue a vast majority of autocallable products. In fact, the liquidity of index dividend swaps is primarily driven by the presence of structured products linked with such an index. As structured products are more common on non-US indices, the implied dividend market is significantly less liquid in the US (especially when compared to the size of the equity market).

Beside the structure retail product, there are other possible factors affecting the structural demand and supply of dividends. During certain periods (SX5E in 2012), dealers hold excess inventory of puts, leaving them long dividend exposure. There was also an increasing demand for upside exposure in Europe and Japan via long-dated calls in 2013 fueled partially by low implied option volatilities. Dealers selling calls and shorting forward depressed dividend prices in such markets during that period.

Intermediaries' needs in hedging their dividend risk are due to their limited risk-bearing capacities. Trading desks in investment banks are not only concerned about daily profits and losses along with their fluctuations, but also subjected to various risk evaluation from their internal risk departments. On top of that, banks as a whole are also subjected to external pressures, such as balance sheet constraints from Basel III.

4 Model and Model Implications

Actual dividend markets have two active participants: banks and institutional investors. Fund and proprietary trading desks still account for roughly 80% of the dividend markets.

This paper models two types of players in the dividend markets: end-users and dealers. End-users include retailers demanding structured products. They act as an exogenous supplier of dividends. Dealers include banks and institutional investors whose risk capacities will determine dividend prices.

4.1 Model Setup

We will propose a supply-based dividend pricing model that closely resembles the demand-based option pricing model of Garleanu et al. (2009).

Consider an infinite-horizon discrete-time economy with two types of players: end-user and dealers. There are two types of assets: riskfree and risky assets. Riskfree assets have constant returns of R_f, while risky assets are equities with exogenous strictly positive price P_t^e, dividend D_t, and excess returns of $R_t^e = \frac{P_t^e + D_t}{P_{t-1}^e} - R_f$. The distribution of future

20

prices and returns are governed by Markov state variables X_t such that $X_t^1 = P_t^e$. Assume that (R_t^e, X) satisfies a Feller-type condition as discussed in Appendix F and X_t is bounded for all t.

This economy has a number of dividend securities indexed by $n \in N$, where n contains information such as maturity. The prices of these securities are denoted by p^n and will be determined endogenously. The set of derivatives tradable at time t is indexed by N_t.

End-users will exogenously supply dividends of $q_t = (q_t^n)_{n \in N_t}$ at time t. The distribution of future supplies is assumed to be characterized by X_t.

Dealers are competitive with a representative deal with discount factor ρ and constant absolute risk aversion γ. This representative dealer faces the following utility maximizing problem:

$$\max_{C_t, \theta_t, d_t = d_t^n \, n \in N_t} u(C_t, C_{t+1}, ...) = \mathbb{E}_t \Big[\sum_{v=t}^{\infty} \rho^{v-t} u(c_v) \Big], \tag{8}$$

where d_t is the number of dividends held, θ_t is the dollar investment in the underlying equity, $u(C) = -\frac{e^{-\gamma C}}{\gamma}$, and such that the following hold:

$$W_{t+1} = (W_t - C_t) R_f + d_t (p_{t+1} - R_f p_t) + \theta_t R_{t+1}^e, \tag{9}$$

$$\lim_{T \to \infty} \mathbb{E}_t [\rho^{-T} e^{-k W_T}] = 0. \tag{10}$$

Dividend prices will be determined in a competitive equilibrium.

Definition 1 $p_t = p_t(q_t, X_t)$ *is a (competitive Markov) equilibrium if, given p, dealer's optimal holding of dividends clears the market, i.e. $d = q$.*

4.2 Solving Dealers' Problem

Let $J(W_t; t, x)$ be the value function at time t of the dealer with wealth W_t and facing the state of nature X_t. We can rewrite the dealer's optimization problem in (8) to

$$\max_{C_t, d_t, \theta_t} -\frac{1}{\gamma} e^{\gamma C} + \rho \mathbb{E}_t [J(W_{t+1}; t+1, X_{t+1})], \tag{11}$$

such that the resource constraint (9) holds.

Lemma 2 *If $p_t = p_t(q_t, X_t)$ s the equilibrium price process and $k = \frac{\gamma(R_f - 1)}{R_f}$. Then, dealer's*

value function and optimal consumption are given by

$$J(W_t; t, X_t) = -\frac{1}{k} e^{-k(W_t + G_t(q_t, X_t))} \tag{12}$$

$$C_t = \frac{R_f - 1}{R_f}(W_t + G_t(q_t, X_t)), \tag{13}$$

and stock and dividend holdings are characterized by the respective first-order conditions:

$$0 = \mathbb{E}_t[e^{-k(\theta_t R^e_{t+1} + d_t(p_{t+1} - R_f p_t) + G_{t+1}(q_{t+1}, X_{t+1}))} R^e_{t+1}] \tag{14}$$

$$0 = \mathbb{E}_t[e^{-k(\theta_t R^e_{t+1} + d_t(p_{t+1} - R_f p_t) + G_{t+1}(q_{t+1}, X_{t+1}))}(p_{t+1} - R_f p_t)], \tag{15}$$

where, for $t \leq T$, $G_t(q_t, X_t)$ is derived recursively using equations (14) *and* (15) *and*

$$e^{-kR_f G_t(q_t, X_t)} = R_f \rho \mathbb{E}_t[e^{-k(\theta_t R^e_{t+1} + d_t(p_{t+1} - R_f p_t) + G_{t+1}(q_{t+1}, X_{t+1}))}]. \tag{16}$$

For $t > T$, the function $G_t(q_t, X_t) = \bar{G}(x_t)$, where $(\bar{G}(x_t), \bar{\theta}(x_t))$ solves

$$e^{-kR_f \bar{G}(x)} = R_f \rho \mathbb{E}_t[e^{-k(\bar{\theta} R^e_{t+1} + \bar{G}(x_{t+1}))}] \tag{17}$$

$$0 = \mathbb{E}_t[e^{-k(\bar{\theta} R^e_{t+1} + \bar{G}(x_{t+1}))} R^e_{t+1}]. \tag{18}$$

The optimal consumption is unique. The optimal dividend security holdings are unique provided that their payoffs are linearly independent.

The proof of Lemma 2 is in Appendix F.

4.3 Price Effects of Supply Pressure

At maturity T, dividends have a known price of p_T. At any prior date t, the price p_t can be found recursively by inverting the equation (15) to get

$$p_t = \frac{\mathbb{E}_t[e^{-k(\theta_t R^e_{t+1} + q_t p_{t+1} + G_{t+1})} p_{t+1}]}{R_f \mathbb{E}_t[e^{-k(\theta_t R^e_{t+1} + q_t p_{t+1} + G_{t+1})}]}, \tag{19}$$

where the hedge position in the underlying θ_t solves

$$0 = \mathbb{E}_t[e^{-k(\theta_t R^e_{t+1} + q_t p_{t+1} + G_{t+1})} R^e_{t+1}], \tag{20}$$

and G is computed recursively as in Lemma 2.

Equations (19) and (20) can be written in terms of supply-based pricing kernels.

Theorem 3 *Price p and the hedge position θ satisfy*

$$p_t = \mathbb{E}_t(m_{t+1}^q p_{t+1}) = \frac{1}{R_f}\mathbb{E}_t^q(p_{t+1}) \tag{21}$$

$$0 = \mathbb{E}_t(m_{t+1}^q R_{t+1}^e) = \frac{1}{R_f}\mathbb{E}_t^q(R_{t+1}^e), \tag{22}$$

where the pricing kernel m^q is a function of supply pressure q:

$$m_{t+1}^q = \frac{e^{-k(\theta_t R_{t+1}^e + q_t p_{t+1} + G_{t+1})}}{R_f \mathbb{E}_t\left[e^{-k(\theta_t R_{t+1}^e + q_t p_{t+1} + G_{t+1})}\right]}, \tag{23}$$

and $\mathbb{E}_t^q$ is the expected value with respect to the corresponding risk-neutral measure, i.e. the measure with a Radon-Nikodym derivative with respect to the objective measure of $R_f m_{t+1}^q$.

Note that the pricing kernel is small whenever the unhedgeable part $d_t p_{t+1} + \theta_t R_{t+1}^e$ is large.

Definition 4 *The unhedgable price change $\bar{p}_{t+1}^n$ of any dividend strips n is defined as its excess return $p_{t+1}^n - R_f p_t^n$ optimally hedged with underlying equity position $\frac{cov_t^q(p_{t+1}^n, R_{t+1}^e)}{var_t^q(R_{t+1}^e)}$:*

$$\bar{p}_{t+1}^n = R_f^{-1}\left(p_{t+1}^n - R_f p_t^n - \frac{cov_t^q(p_{t+1}^n, R_{t+1}^e)}{var_t^q(R_{t+1}^e)}R_{t+1}^e\right). \tag{24}$$

Theorem 5 *The sensitivity of the price of dividend security n to supply pressure in dividend security o is proportional to the covariance of their unhedgeable risks:*

$$\frac{\partial p_t^n}{\partial q_t^o} = -\gamma(R_f - 1)\mathbb{E}_t^q(\bar{p}_{t+1}^n \bar{p}_{t+1}^o) = -\gamma(R_f - 1)cov_t^q(\bar{p}_{t+1}^n, \bar{p}_{t+1}^o). \tag{25}$$

Theorem 5 says that the supply of dividend security *o* has an effect on the price of dividend security *n* as long as the unhedgeable risks of dividend securities *o* and *n* correlate with each other.

If we set $o = n$ in Theorem 5, we have that higher exogenous supply of dividend security *n* will lead to lower dividend prices.

5 The Effect of Structured Products on T-Maturity Asset Prices, Yields, and Yield Term Structure

According the the supply-based asset pricing model, exogenous dividend supply of certain maturities affects asset prices and returns. In our context, structured retail products will affect the equity term structure if the following key identifying assumption is true: exotic products are a proxy for exogenous dividend supply.

A priori, dividend yields may affect the demand of structured product issuance. The risk-reward profile of structured products depends on many factors, one of which is the dividend curve. That is, dividend levels can affect the amount of exotic trading. This potential simultaneity issue may confide our empirical results.

This section aims to evaluate our proposed mechanism by testing the effect of structured product issuance on asset prices, returns, and price term structure.

5.1 Data

We obtain structured product issuance data from mtn-i.com. This database contains precise and consistent data on underlyings for the US SEC registered market from 2014 onward and for the Canadian and Japanese domestic retail markets from 2015 onward. Data for other markets or further back in time is patchier.

Data is presented trade by trade with ISIN (the International Securities Identification Number) along with dealer name, issuer name, trade size, trade coupon, asset class, product type, settlement date, and maturity date.

The raw data contains all trades with SX5E, UKX, SPX, KOSPI2, NKY, HSI, and HSCEI Index as underlyings. I restrict the sample to only equity-linked trades. For trades with multiple underlyings (basket or worst-of structures), the total notional is divided equally across each associated underlying index.

5.2 Empirical Strategy

Since structured products are complicated instruments with complex risk, we make certain simplifying assumptions to connect the issuance data to the amount of dividend supplied.

Ideally, we need not just the notional of each trade but also dividend exposure associated with each product. Each instrument has different dividend risk. Dissecting dividend risk for each trade is possible if we have pricing models similar to those in investment

banks. Since there is no easy way to extract actual dividend exposure, we assume that dividend risk is just proportional to the issuance amount.

In addition, without investment bank risk management tools, it becomes impossible to categorize dividends for each maturity bucket. 5-year structured products may have higher sensitivity to 3-year dividends than to 5-year dividends. This paper will not attempt to bucket dividend risk. We leave refinement of this process to future research.

In addition, the dividend exposure for each trade is spot- and time-dependent. Dividend risk for each instrument depends on the performance of underlying equities. This paper assumes constant dividend exposure throughout the life of each trade.

Relatedly, some products might actually knock out early or get unwinded and cease to exist. Since we only have data on settlement date and maturity date, we cannot keep track of which instrument has knocked out (Our data does not contain specific terms such as knocked out level and strike level, etc.).

Given the above assumptions, I aggregate the total issuance for each respective date and underlying index by adding up the notional of all trades that have already settled but have not yet matured.

Formally, let q_t^i be the amount of dividends related to index i at time t. According to our model, the part driving dividend prices is the unhedgable risk part. As long as the market is extremely liquid, a high volume of dividend supply can be absorbed. We therefore construct the normalized dividend amount nq_t^i to be the total dividend divided by the total volume of index traded in the market. Here, we use the volume of index traded as a proxy for the depth of dividend markets. Better normalization can use the total traded volume of dividend swaps and dividend futures. However, dividend swaps are traded over-the-counter, and we currently do not have access to this data.

We will assume that the aggregate structured product issuance is a proxy of the dividend supply. From the data, both the total issuance and the normalized total issuance are nonstationary. To get around such issues, we group the data by quarter and stationalize each series by taking first difference or log difference depending on whether the series has a linear or exponential trend. We then run the analysis on these differenced series. Appendix G displays the constructed total issuance notional related to each index along with the quarter-by-quarter percentage change in notional issuance.[6]

---

[6]There appears to be a structural break in the notional issuance around 2014, which may be due to the fact that data is less comprehensive prior to 2014. We check the robustness of the results in this section by dividing the data into the pre- and post-2014 samples. Results appear to be robust as shown in Appendix ??.

5.3 Price & Yield Regression

Let $P^i_{t,T}$ be the price of T-maturity asset related to index i at time t, $\delta^i_{t,T}$ be the index i T-maturity dividend yield at time t, S^i_t be the index i level at time t, and R^i_t be the monthly return of index i at time t.

Denote the quarterly-average price, yield, index level, and index return by $P^{i,qtr}_{t,T}$, $\delta^{i,qtr}_{t,T}$, $S^{i,qtr}_t$, $R^{i,qtr}_t$ respectively. Let $nq^{i,qtr}_t$ and $niss^{i,qtr}_t$ be the quarterly sum of the normalized dividend amount and the quarterly sum of the normalized structured product issuance, where t is now in the unit of quarterly.

We assume that $nq^{i,qtr}_t \propto niss^{i,qtr}_{t-1}$, i.e. the sum of the normalized dividend amount in the current quarter is proportional to the sum of normalized structured product issuance from the previous quarter. We make such an assumption for the following reasons. First, we try to work around the simultaneity issue. Structured product issuance is likely higher when dividend yields are higher, as investor payoffs will become more appealing. We believe that the price effect of supply persists for some quarters in the future. Therefore, using the lagged percentage change can provide a lower bound on the exact magnitude of the impact. Second, intermediaries usually take some time in recycling their risk from exotic trades.

We consider the following time series regressions for T = 1, 2, 3, and 5 years and i represents SPX, SX5E, NKY, UKX, NKY, KOSPI2, HSI, and HSCEI as well as their panel regression analogs.

$$\Delta P^{i,qtr}_{t,T} = \kappa^{i,P}_T + \eta^{i,P}_T \Delta \log nq^{i,qtr}_t + \epsilon^P_T \tag{26}$$

$$\Delta P^{i,qtr}_{t,T} = \kappa^{i,P}_T + \eta^{i,P}_T \Delta \log nq^{i,qtr}_t + \lambda^{i,S}_T \Delta \log S^{i,qtr}_t + \epsilon^P_T \tag{27}$$

Regression equations (27) and (26) test for the effect of the percentage change of 1-quarter-lag normalized structured product issuance on the change of dividend yields with and without controlling for the percentage change in spot level respectively.

Table 4 shows the panel regression results controlling for both country-specific and time-specific effects. Even though the coefficient in front of the log difference of dividend amount is negative, it is insignificantly so. 1-quarter lagged issuance does not seem to have a noticeable effect on dividend prices.

Regression equation (27) controls for the level effect (dividend prices might track the spot level). The coefficient in front of the log difference of spot level is indeed significantly positive. Whenever equity index goes higher, finite-maturity dividend prices also go up.

As prices of longer-maturity assets should always be higher than those of assets that cover less dividend payments, it is hard to do a comparison across maturity using the

Table 4: Price Regression

| | $T = 1$ | | $T = 2$ | | $T = 3$ | | $T = 5$ | |
	(26)	(27)	(26)	(27)	(26)	(27)	(26)	(27)
$\Delta \log nq_t^{i,qtr}$	-12.32	-6.879	-32.09	-16.78	-53.18	-25.75	-98.25	-44.98
	(-1.07)	(-0.92)	(-1.26)	(-1.12)	(-1.31)	(-1.14)	(-1.40)	(-1.17)
$\Delta \log S_t^{i,qtr}$		105.8*		297.8***		533.4***		1035.6***
		(2.66)		(3.88)		(4.76)		(5.78)
N	319	319	319	319	319	319	319	319
Adj. R^2	0.0116	0.0839	0.0185	0.153	0.0196	0.187	0.0183	0.190

Notes: Data from Q4 2004 - Q4 2016. Panel Regression with Fixed Effect. t statistics using Driscoll-Kraay standard error in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

price data. To enable the comparison across maturity, we turn to the yield regression. Dividend yields are dividend prices normalized by the spot level as well as the maturity.

In particular, we consider the following regression equations:

$$\Delta \delta_{t,T}^{i,qtr} = \kappa_T^{i,\delta} + \eta_T^{i,\delta} \Delta \log nq_t^{i,qtr} + \epsilon_T^{\delta} \tag{28}$$

$$\Delta \delta_{t,T}^{i,qtr} = \kappa_T^{i,\delta} + \eta_T^{i,\delta} \Delta \log nq_t^{i,qtr} + \lambda_T^{i,R} \Delta R_t^{i,qtr} + \epsilon_T^{\delta}. \tag{29}$$

Regression equation (28) looks at the impact of lagged structured product issuance on dividend yields. According to our story, $\eta_T^{i,\delta}$ should be negative, i.e. a percentage increase in lagged total issuance should impact dividend prices and thus lead to a percentage decrease in dividend yields.

Equation (29) tests for the effect of a percentage increase in the dividend supply on the percentage change in dividend yields controlling for the percentage change in index return.

Table 5: Yield Regression

| | $T = 1$ | | $T = 2$ | | $T = 3$ | | $T = 5$ | |
	(28)	(29)	(28)	(29)	(28)	(29)	(28)	(29)
$\Delta \log nq_t^{i,qtr}$	0.0002	0.0002	-0.0002	-0.0002	-0.0004	-0.0003	-0.0006	-0.0005
	(0.66)	(0.70)	(-0.46)	(-0.33)	(-1.03)	(-0.93)	(-1.40)	(-1.32)
$\Delta R_t^{i,qtr}$		-0.0010		-0.0025		-0.0030		-0.0037
		(-0.43)		(-1.07)		(-1.22)		(-1.79)
N	319	319	319	319	319	319	319	319
Adj. R^2	0.0010	0.0023	0.0009	0.0135	0.0054	0.0254	0.0085	0.0296

Notes: Data from Q4 2004. Panel Regression with Fixed Effect. t statistics using Driscoll-Kraay standard error in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Results from the panel regression controlling for both index-specific and time-specific effects is shown in Table 5. The coefficient in front of the log difference of dividend amount is insignificantly negative. 1-quarter lagged issuance does not seem to affect contempora-

neous dividend yields.

Controlling for the change in index return does not change the effect of the percentage increase in dividend supply on changes in dividend yields. The coefficient in front of the change in index return is negative but insignificantly so.

So far, we have determined that structured product issuance seems to have almost no effect on dividend prices and dividend yields. Next, we attempt to filter out all common factors that may drive dividend yields across the curve and instead test whether the percentage increase in the structured product issuance affects any changes in the yield term structure. We consider the following regressions:

$$\Delta(\delta_{t,T_2}^{i,qtr} - \delta_{t,T_1}^{i,qtr}) = \kappa_{T_2,T_1}^{i,\delta} + \eta_{T_2,T_1}^{i,\delta} \Delta \log nq_t^{i,qtr} + \epsilon_{T_2,T_1}^{\delta} \tag{30}$$

$$\Delta(\delta_{t,T_2}^{i,qtr} - \delta_{t,T_1}^{i,qtr}) = \kappa_{T_2,T_1}^{i,\delta} + \eta_{T_2,T_1}^{i,\delta} \Delta \log nq_t^{i,qtr} + \lambda_{T_2,T_1}^{i,R} \Delta R_t^{i,qtr} + \epsilon_{T_2,T_1}^{\delta}. \tag{31}$$

Regression equation (30) tests whether the percentage in the total issuance affects the change in the yield term structure. Higher structured product issuance should depress dividend prices. Since the 1-year dividend is either announced or well-forecasted, the major dividend risk from structured products is around 2, 3, or 5 years depending on the maturity of the trade. We expect that when $T_2 = 2$, 3 or 5, the coefficient $\eta_{T_2,T_1}^{i,\delta}$ should be negative (the yield term structure should be inverted.).

Table 6: Yield Term Structure Regression

	$T_1, T_2 = 1,2$		$T_1, T_2 = 1,3$		$T_1, T_2 = 2,3$		$T_1, T_2 = 1,5$		$T_1, T_2 = 2,5$		$T_1, T_2 = 3,5$	
	(30)	(31)	(30)	(31)	(30)	(31)	(30)	(31)	(30)	(31)	(30)	(31)
$\Delta \log nq_t^{i,qtr}$	-0.0004	-0.0004	-0.0006*	-0.0006*	-0.0003*	-0.0002*	-0.0008*	-0.0007*	-0.0004	-0.0004	-0.0002	-0.0002
	(-1.89)	(-1.80)	(-2.23)	(-2.19)	(-2.39)	(-2.42)	(-2.14)	(-2.08)	(-1.93)	(-1.88)	(-1.45)	(-1.37)
$\Delta R_t^{i,qtr}$		-0.0015*		-0.0020*		-0.0004		-0.0020		-0.0005		-0.0001
		(-2.16)		(-2.05)		(-1.26)		(-1.86)		(-0.77)		(-0.13)
N	319	319	319	319	319	319	319	319	319	319	319	319
Adj. R^2	0.0136	0.0277	0.0188	0.0315	0.0149	0.0186	0.0183	0.0264	0.0126	0.0140	0.0062	0.0062

Notes: Data from Q4 2004. Panel Regression with Fixed Effect. t statistics using Driscoll-Kraay standard error in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

From Table 6, the coefficient in front of $\Delta \log nq_t^{i,qtr}$ is significantly negative whenever $(T_2, T_1) = (3,1), (3,2)$, or $(5,1)$ whether we control for the change in index return or not. When there is an increase in the structured product issuance, the 3y1y, 3y2y, and 5y1y term structure becomes more inverted. The 3-year and 5-year dividend yields become more compressed with respect to front-year dividend yields. We view this as the evidence supporting the supply-based asset pricing model.

Individual time-series regression results can be found in Appendix I.

6 Conclusion

This paper has discussed different ways of pricing T-maturity assets. Using comprehensive data for various equity indices around the world, we documented the patterns of T-maturity asset prices and returns. We find that the price and return term structure vary across indices and with time.

The feature of downward-sloping return term structure is discordant with standard macro-finance theories. This paper argues that the key determinant of dividend prices is dividend supply. Looking into the origin of dividend markets, we find that such markets were created due to the need of intermediaries to offload their dividend risks. Banks accumulate dividends from structured product issuance. Inspired by this fact, we propose the market specialization story to explain the variation in T-maturity asset prices.

We argue that structured products present a significant dividend risk to exotic trading desks. Exotic traders have limited risk-bearing capacity and will offload some of the dividend risk to the markets. The dividend supply from exotic traders hence suppresses dividend prices and dividend yields, especially around those with 2 to 5 years maturity. That is, the term structure of implied dividends is more inverted when the volume of structured product issuance is higher.

The proposed supply-based asset pricing model follows closely the demand-based option pricing model of Garleanu et al. (2009). Based on this theory, exogenous dividend supply from structured retail products will impact risky asset prices, returns, and term structure.

Using issuance data from a private vendor, we find that the 3y1y, 3y2y, 5y1y dividend yield term structure is indeed more inverted when the total outstanding issuance of structured products is higher. This provides an empirical basis to our story that structured products indeed impact equity term structure.

Based on our story, investors may take advantage of long dividend (and short equity) trading strategies due to the abnormality of the equity return term structure caused by the structural imbalance from exotic products.

This paper also speaks to policy makers. Exogenous dividend supply has a big impact on dividend prices whenever intermediaries have trouble recycling their risks. In order to eliminate this market anomaly, policy makers should promote greater liquidity in dividend markets. Another debatable approach to eliminate market inefficiency is to allow for greater risk-taking limits in intermediaries.

A Comparison across Different Methods of the Pricing of T-Maturity Assets

A.1 Different Constant Maturities of S&P 500 Index Dividend Yield over Time

This paper has shown that different methods yield roughly in-line 1-year S&P 500-related prices. This section focuses on S&P 500 dividend yields with 2-, 3-, and 5-year maturity.
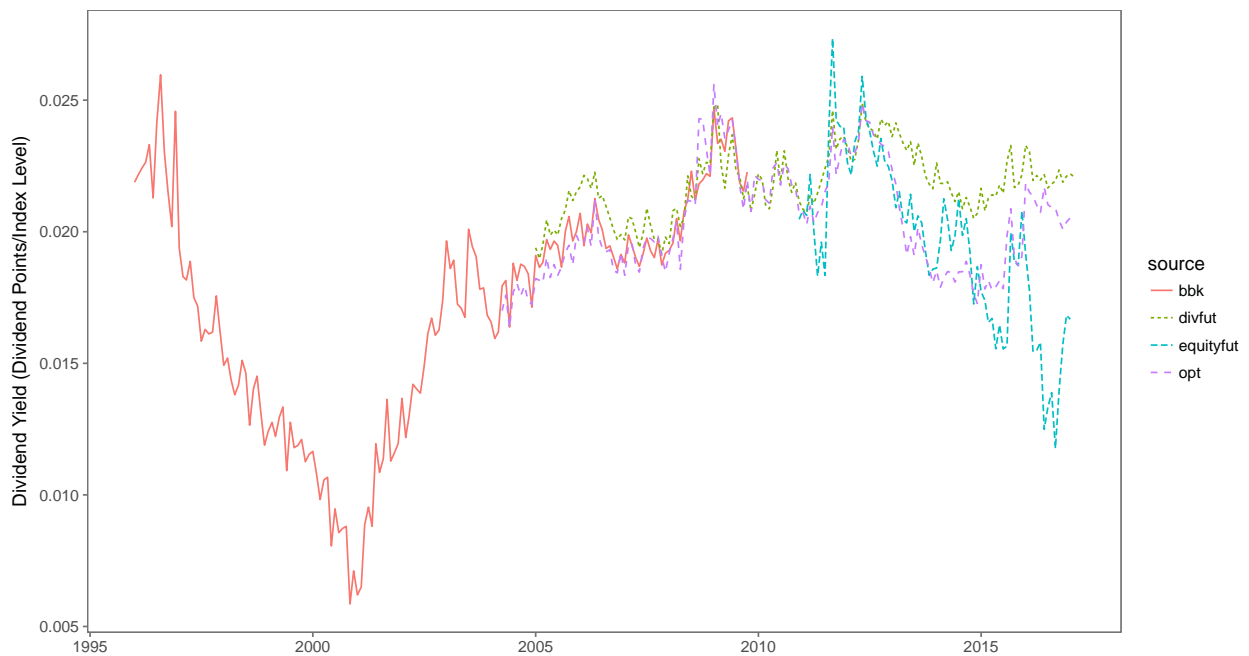

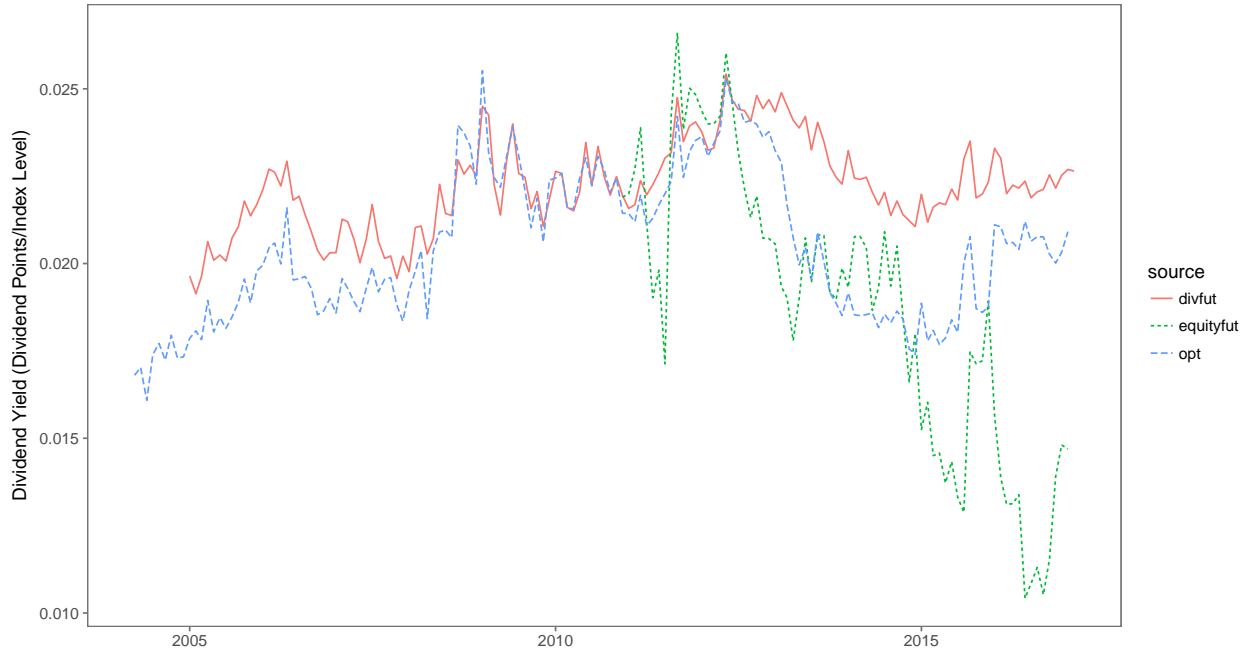Figure 9: 2-Year Dividend Yield of SPX Index over Time

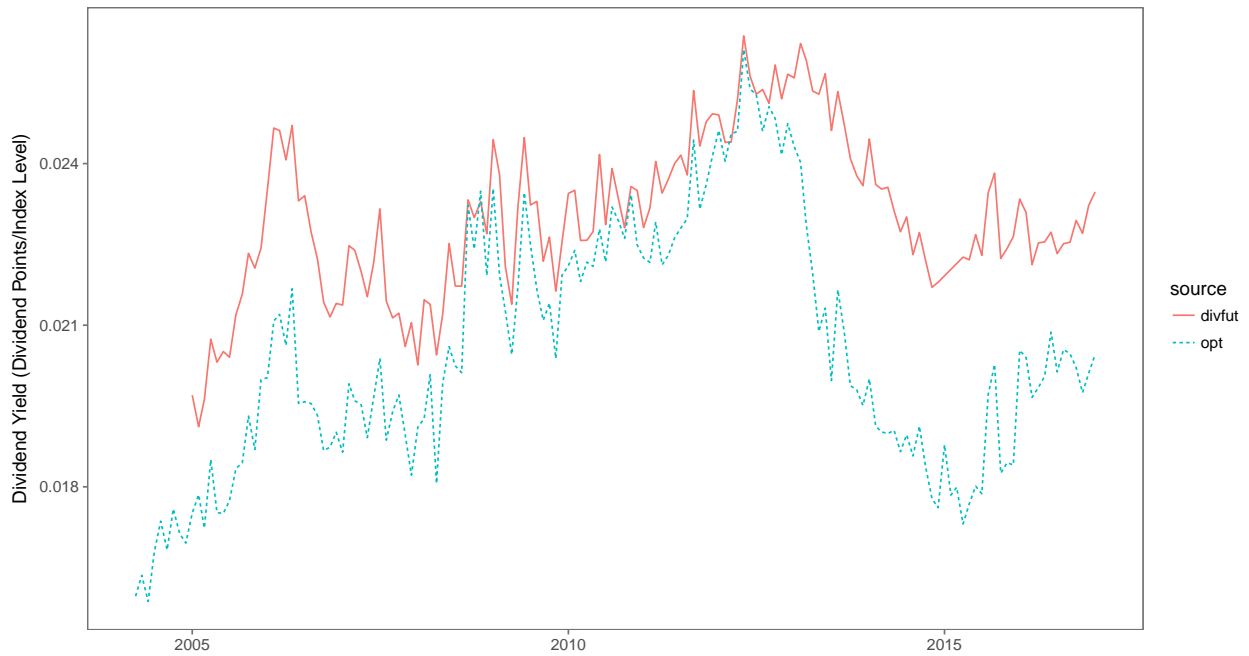Figure 10: 3-Year Dividend Yield of SPX Index over Time

Figure 11: 5-Year Dividend Yield of SPX Index over Time

According to Figure 9, Figure 10, and Figure 11, different data constructing methods for 2-, 3-, and 5-year S&P 500 dividend points align roughly with one another. Data from

Van Binsbergen et al. (2012) does not cover dividends longer than 2 years, and data from equity futures does not cover those longer than 3 years.

A.2 2-Year Dividend Yield for Different Equity Indices over Time

This section now explores beyond S&P 500 dividend yields and tests whether different pricing methods result in comparable 2-year asset prices for Euro Stoxx 50, Financial Time Stock Exchange 100, Nikkei 225, KOSPI 200, Hang Seng, and Hang Seng China Enterprises Index.
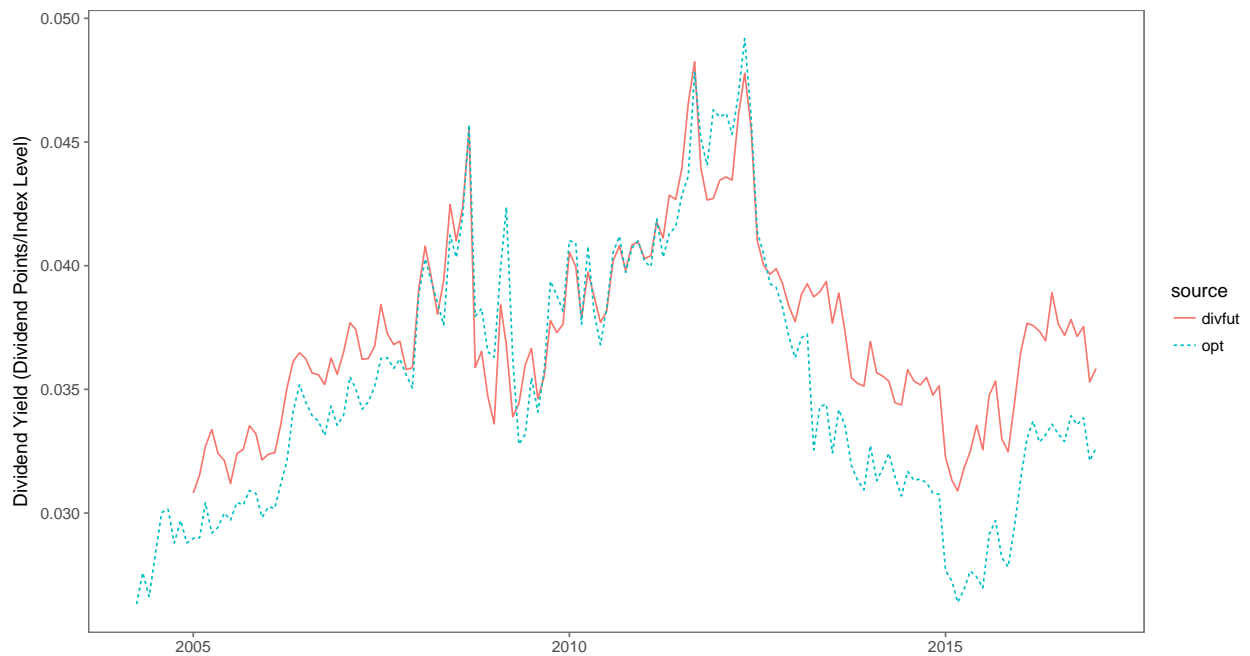

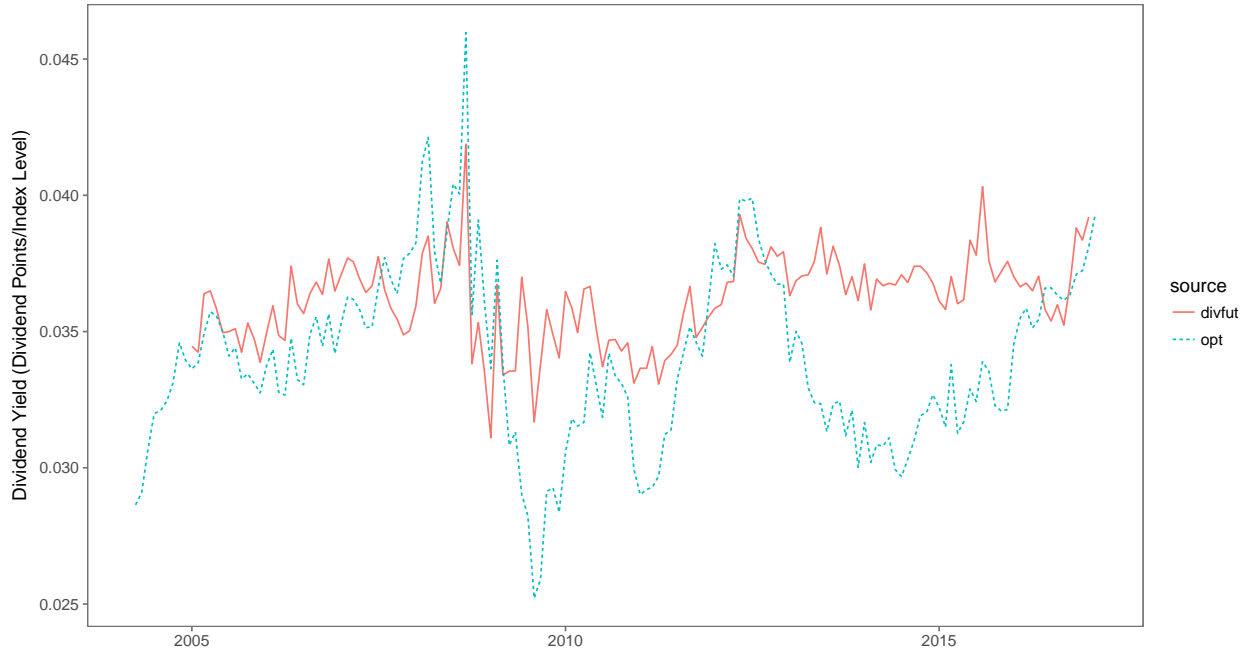Figure 12: 2-Year Dividend Yield of SX5E Index over Time

Figure 13: 2-Year Dividend Yield of UKX Index over Time
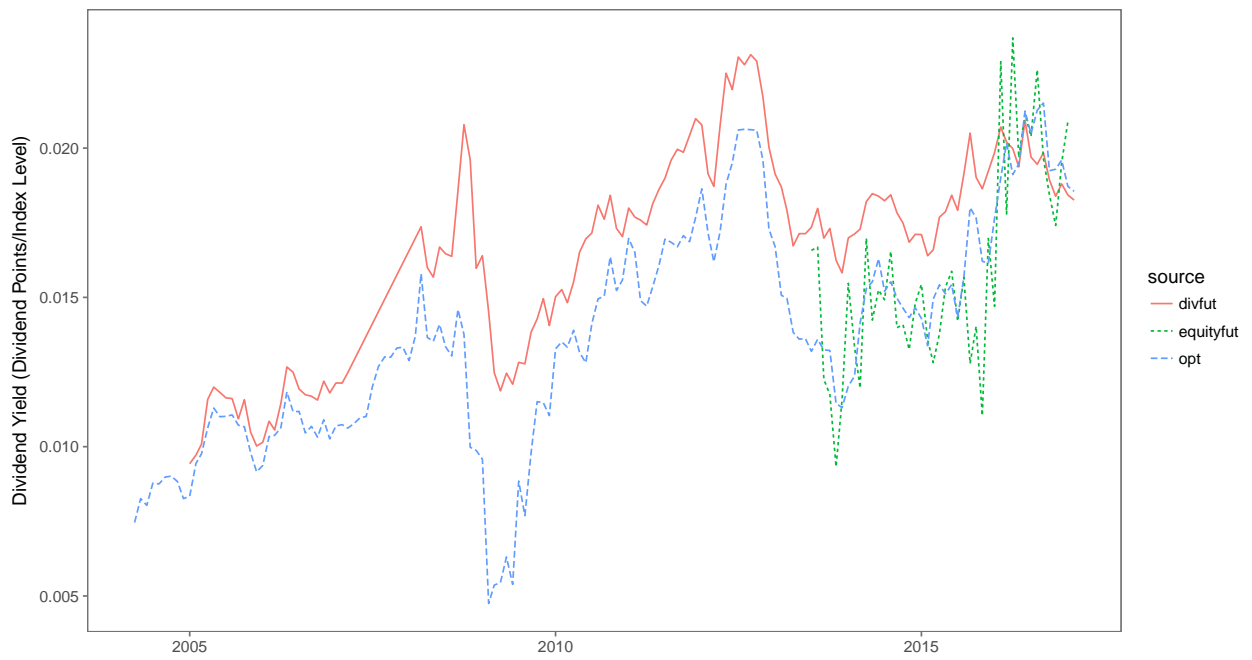
Figure 14: 2-Year Dividend Yield of NKY Index over Time

Figure 15: 2-Year Dividend Yield of KOSPI2 Index over Time
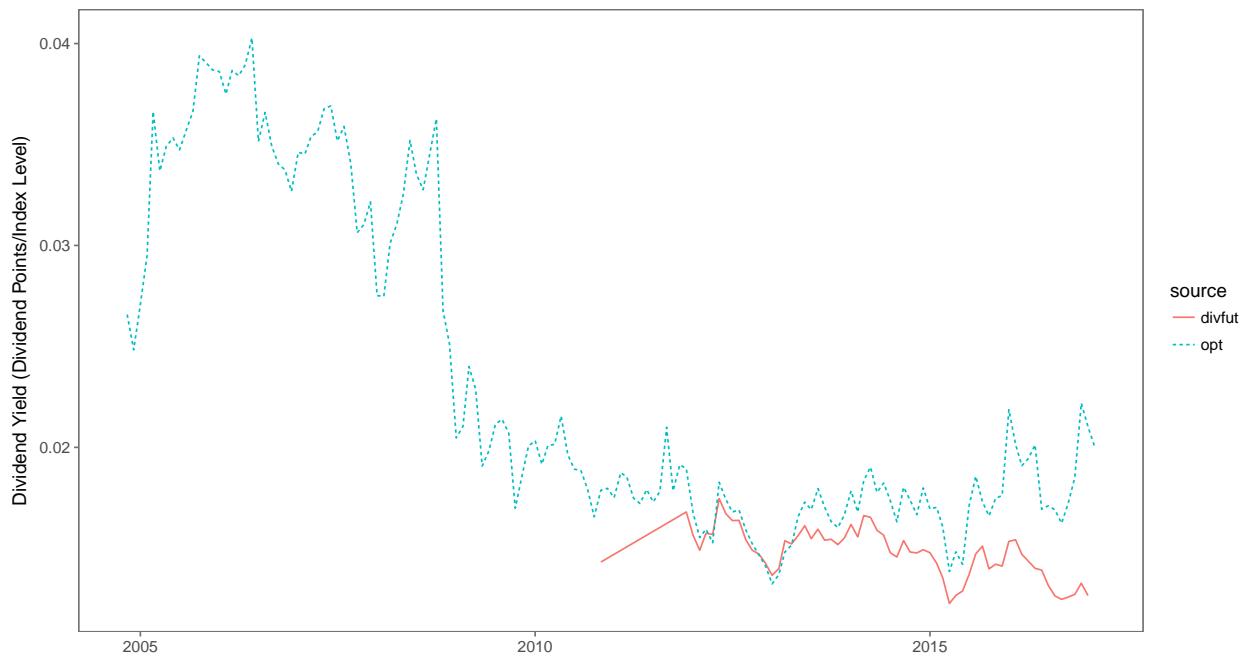
Figure 16: 2-Year Dividend Yield of HSI Index over Time
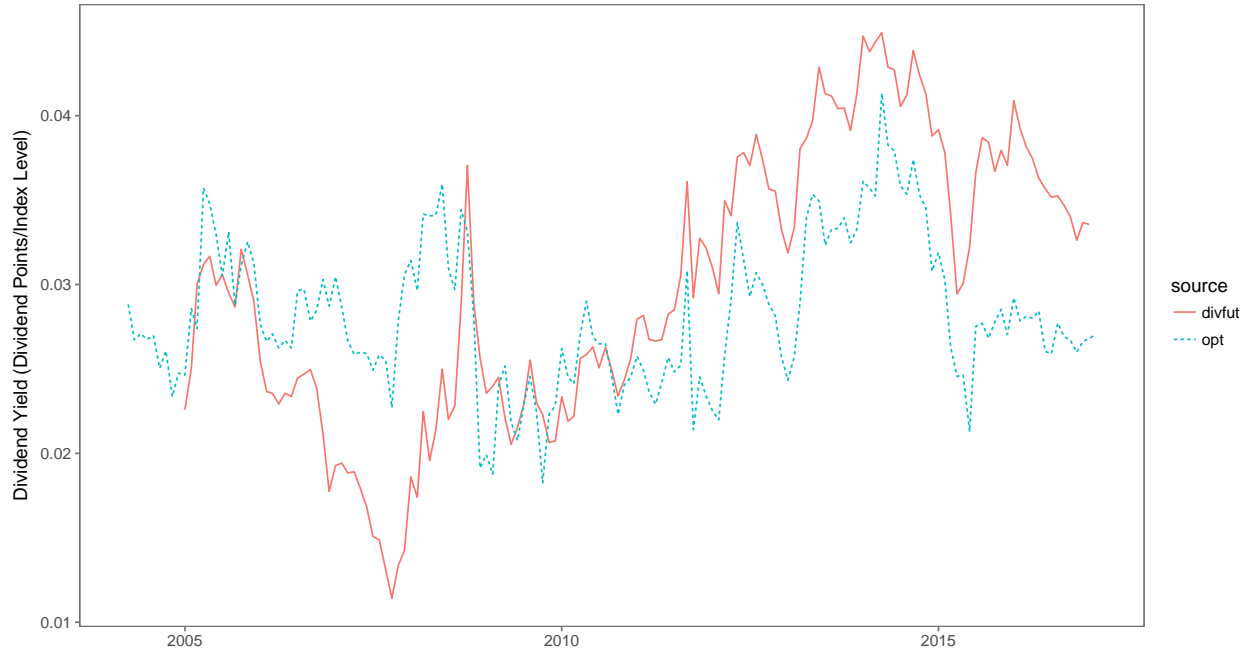
Figure 17: 2-Year Dividend Yield of HSCEI Index over Time

Moving beyond S&P 500, the most comprehensive construction in our paper is the use of synthetic forwards. Dividend futures and swaps cover most of the indices except KOSPI 200.

Figure 12, Figure 13, Figure 14, Figure 15, Figure 16, and Figure 17 show that, whenever data is available, different methods of construction lead to similar T-maturity asset prices.

B *T*-Maturity Dividend Yields over Time for Different Equity Indices
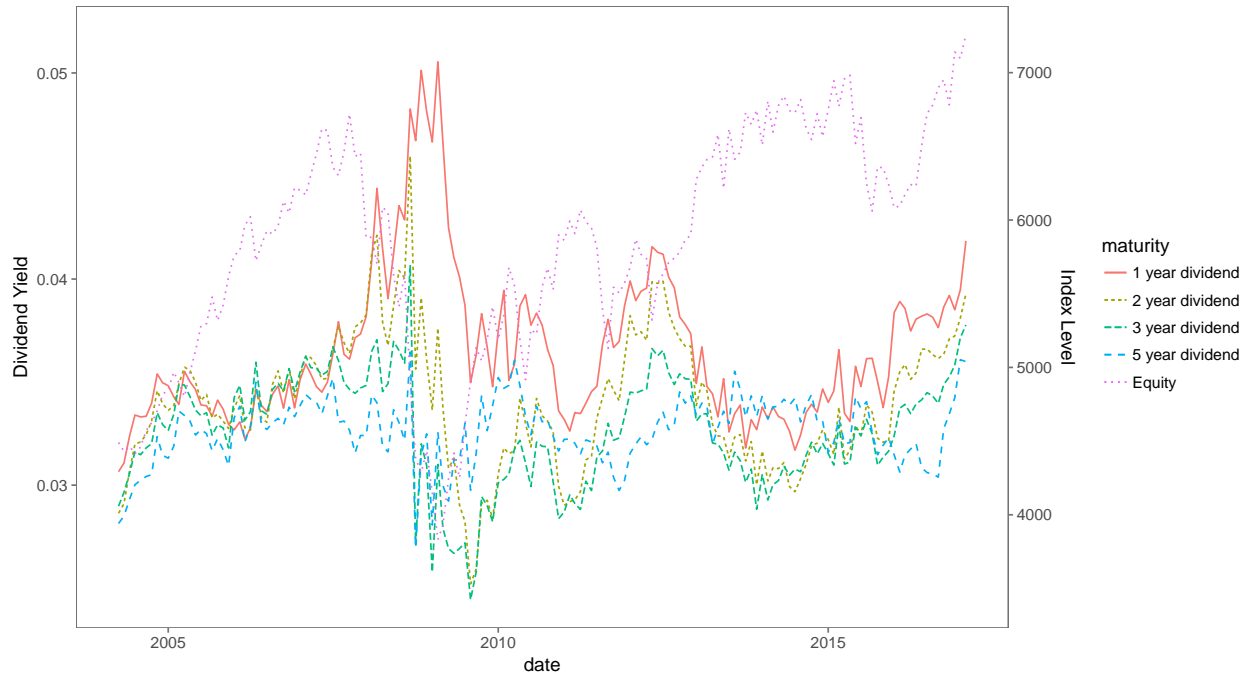
Figure 18: *T*-Maturity Dividend Yield of FTSE 100

Similar to SX5E index, the FTSE 100 dividend yield term structure stays inverted most of the time and is not prominently pro-cyclical.

Figure 19: *T*-Maturity Dividend Yield of KOSPI 200

Figure 19 conveys that KOSPI 200 dividend yield term structure is inverted most of the time like those of European indices. There was a significant drop in dividend yields around 2012 - 2013, which most likely reflects the change in the dividend payout policy among Korean stocks.

Figure 20: *T*-Maturity Dividend Yield of Hang Seng

From Figure 20, the dividend yield term structure of Hang Seng Index used to be inverted up until around 2008 - 2009, after which the HSI yield term structure has the upward sloping shape throughout.
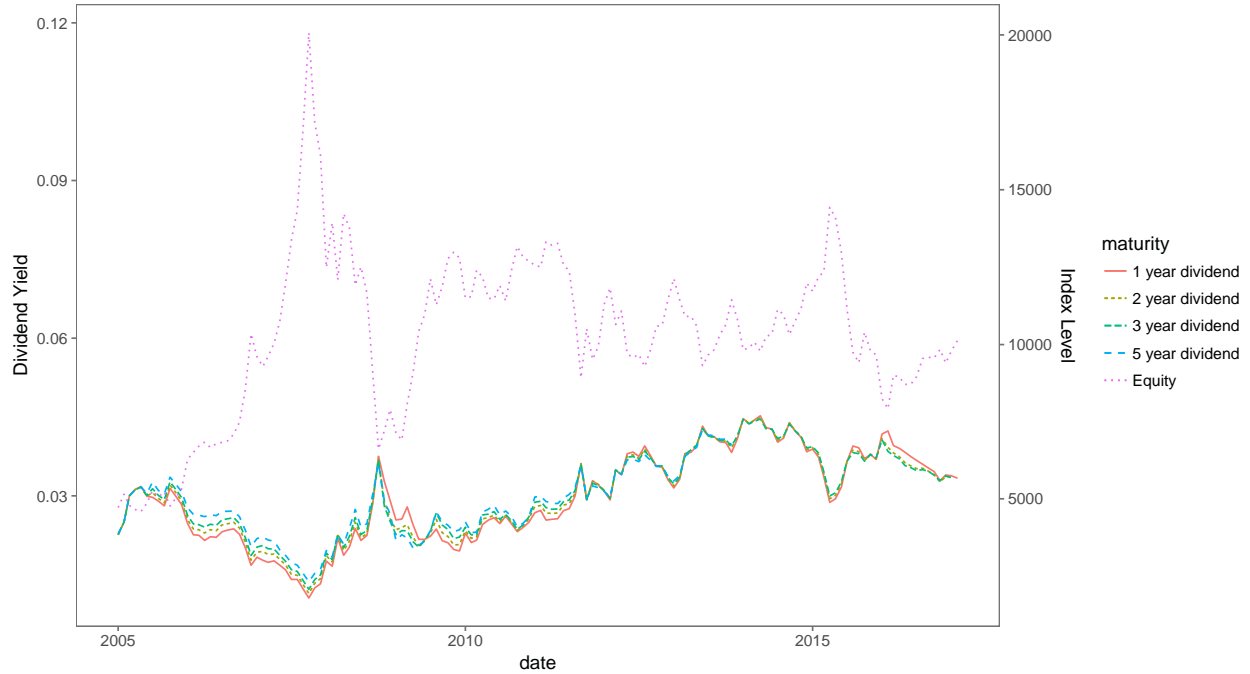
Figure 21: *T*-Maturity Dividend Yield of Hang Seng China Enterprises. Dividend Prices Constructed from Dividend Futures/Dividend Swaps

Figure 21 reflects the dividend yield term structure of HSCEI index over time. HS-CEI dividend prices were constructed from dividend futures/dividend swaps instead of synthetic forwards due to data limitability. We have that the HSCEI dividend yield term structure is usually upward sloping with some periods of the backwardation.

In conclusion, the dividend yield term structure is dynamic. It varies with time and across different equity indices.

C Cumulative Returns of T-Maturity Assets associated with Different Equity Indices
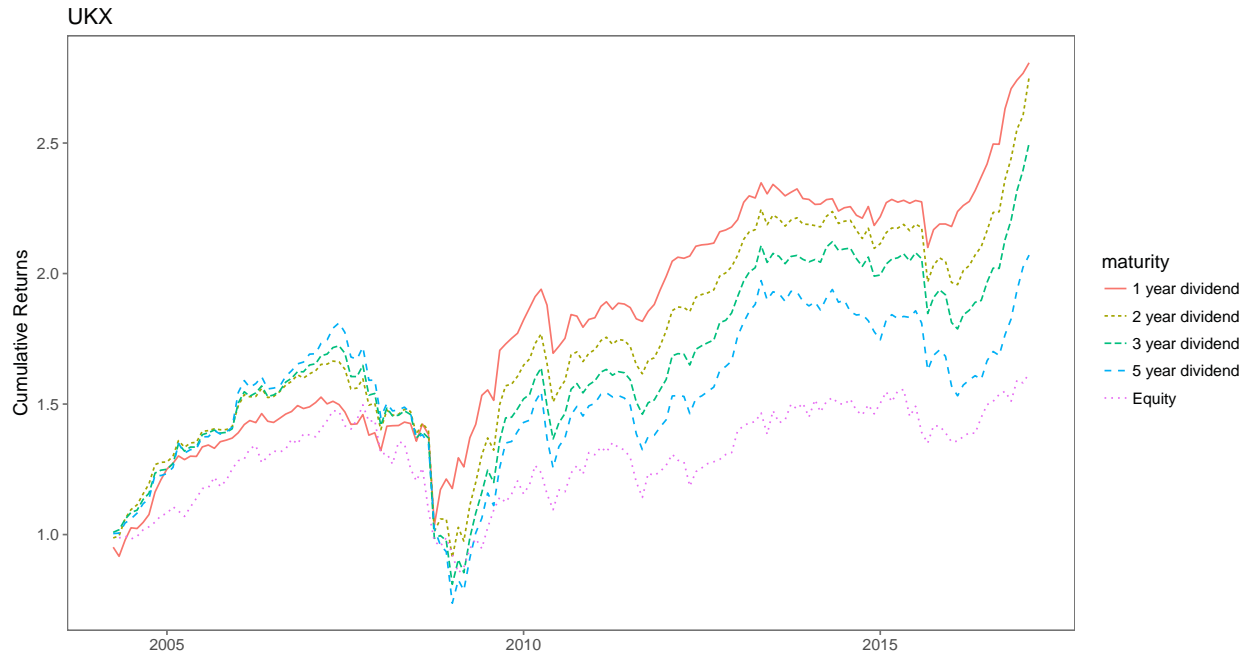
Figure 22: Cumulative Returns of FTSE 100 T-Maturity Asset

Similar to the SX5E Index, the FTSE 100 term structure stays inverted throughout the period of our study as depicted in Figure 22. Coincidentally, UKX Index is also a popular underlying for exotic structures.
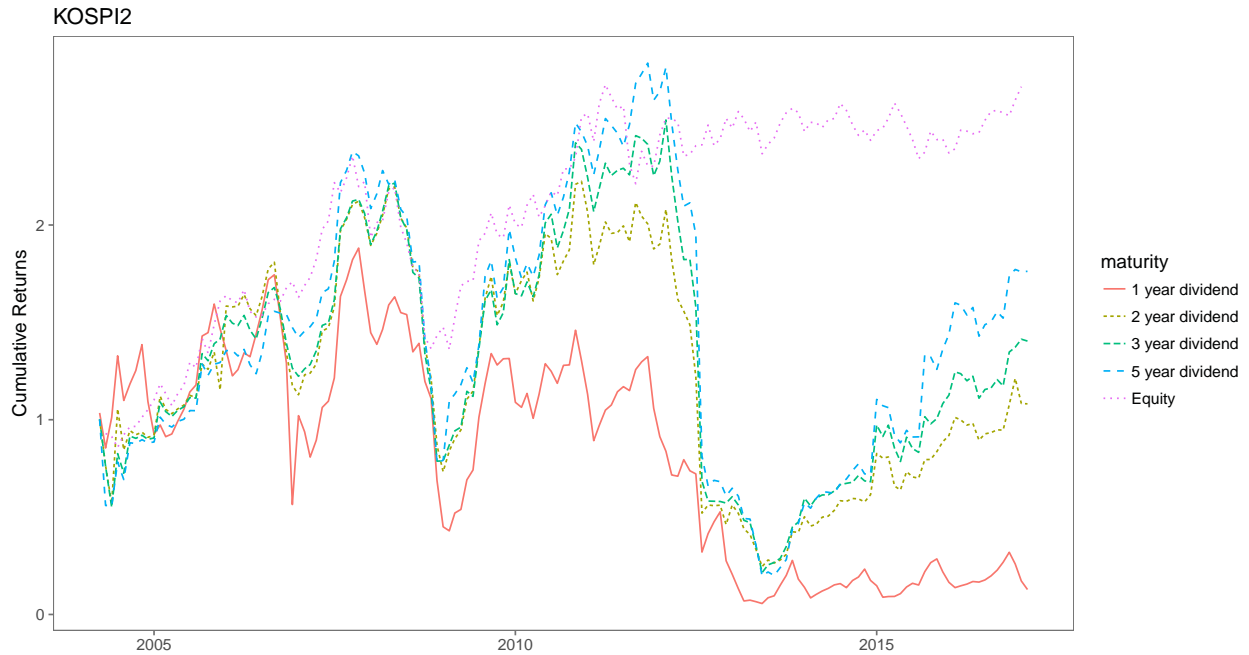
Figure 23: Cumulative Returns of KOSPI 200 T-Maturity Asset

Figure 23 conveys that the KOSPI 200 risky term structure varies with time. There was also a significant drop in the finite-maturity asset prices during 2012 - 2013 due to a change in the dividend payout policy of Korean stocks.
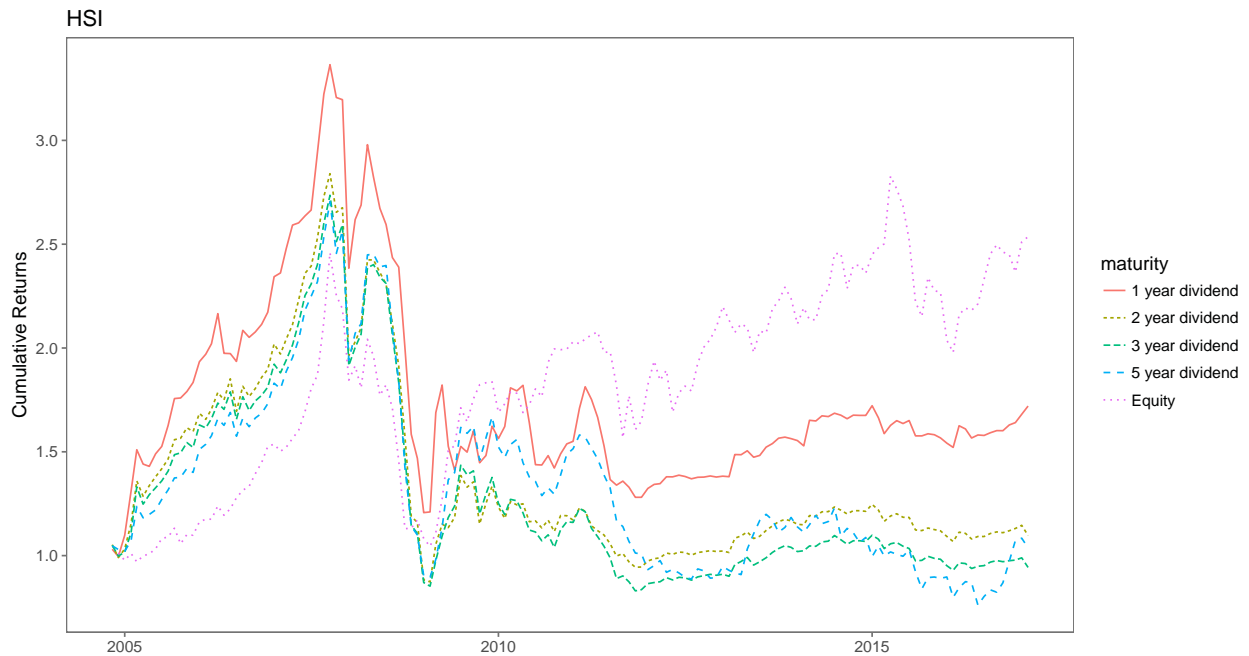
Figure 24: Cumulative Returns of Hang Seng T-Maturity Asset
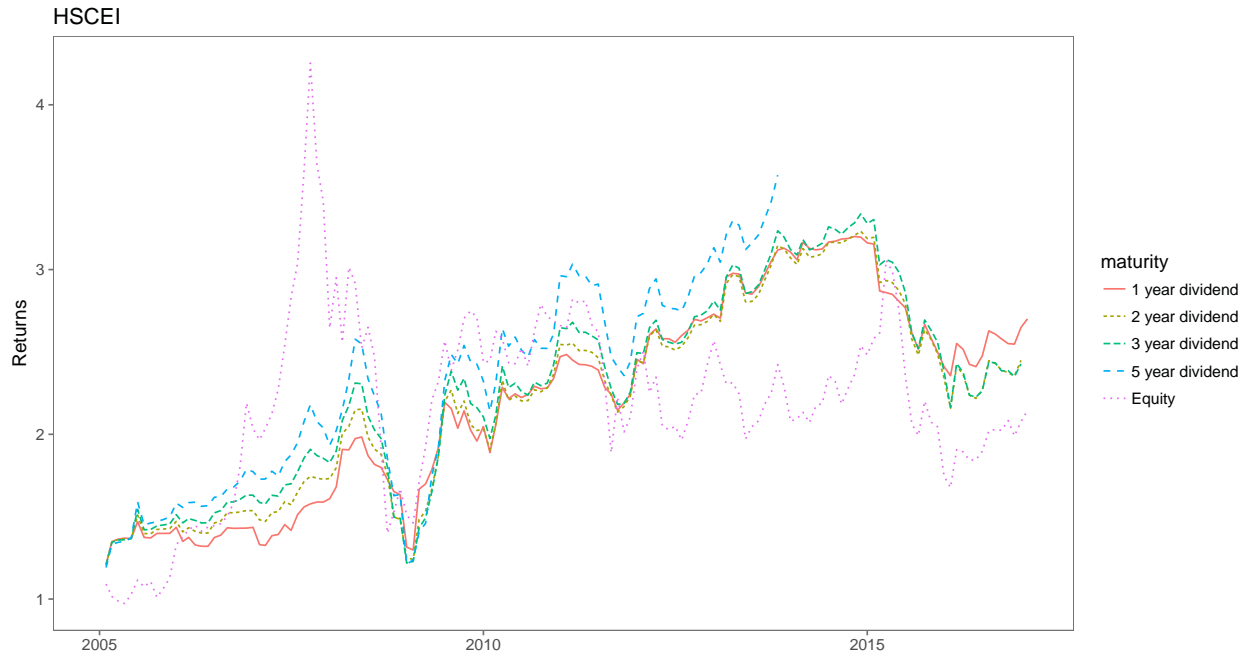
Figure 25: Cumulative Returns of Hang Seng China Enterprises T-Maturity Asset. Dividend Prices Constructed from Dividend Futures/Dividend Swaps

Figure 24 and Figure 25 show that HSI-linked and HSCEI-linked assets have return patterns that vary over time.

Overall, cumulative returns across different equity indices over time confirm that the risky term structure is not static. Such term structure is sometimes upward sloping, while it is downward sloping in other periods.

D Properties of T-Maturity Asset Returns

Table 7 is the analog of Table 2 in the main paper.

From Table 7, UKX assets with shorter maturity have higher mean returns with comparable standard deviations. This results in the downward-sloping Sharpe ratio. This fits well with the observation that FTSE 100 is one of the popular underlyings for structured product issuance.

KOSPI 200 shorter-maturity assets have high returns but are also highly volatile. The resulting sharpe ratio is monotonically increasing with maturity. Hang Seng mean returns are monotonically increasing with maturity with comparable standard deviations. Therefore, the resulting sharpe ratio also increases with maturity. For Hang Send China Enterprises, returns are roughly similar for all maturities with lower standard deviations

for shorter maturities. The sharpe ratio associated with HSCEI therefore has an inverted term structure.

Table 8 is the analog of Table 3 in the main paper.

From table 8, beta is increasing in maturity for all UKX, KOSPI, HSI, and HSCEI Index. There is no excess alpha except for UKX, where alpha for 1-, 2-, 3-, and 5-year assets are significantly positive.

E Sample Termsheet for Autocallables

BARCLAYS

TERM SHEET

(13/08/15)

Series Number: NX00174903
Private Placement
Issued under the Offering Circular dated 24 June 2015

ISIN: XS1245179665
Common Code: 124517966

Worst-of European Barrier Quanto Autocallable Notes linked to a Basket of Equity Indices and ETFs

CAPITAL AT RISK

NO PUBLIC OFFERS PERMITTED. THE DOCUMENTATION FOR THE ISSUANCE OF THESE SECURITIES HAS NOT BEEN REVIEWED OR APPROVED BY ANY REGULATORY AUTHORITY, AND SUCH SECURITIES MAY NOT BE OFFERED, SOLD, OR RE-SOLD TO THE PUBLIC IN THE EUROPEAN ECONOMIC AREA ("EEA") OR ANY OTHER REGION. ANY OFFER, SALE OR RE-SALE OF THESE SECURITIES IN THE EEA OR ANY OTHER REGION MAY ONLY BE MADE PURSUANT TO AN EXEMPTION FROM THE REQUIREMENT TO PUBLISH A PROSPECTUS UNDER THE PROSPECTUS DIRECTIVE AND IN COMPLIANCE WITH ALL OTHER RELEVANT LAWS AND REGULATIONS.

FURTHER, THESE SECURITIES HAVE NOT BEEN AND WILL NOT BE REGISTERED UNDER THE U.S. SECURITIES ACT OF 1933, AS AMENDED, AND MAY NOT BE OFFERED, SOLD, RE-SOLD OR DELIVERED WITHIN THE UNITED STATES OR TO, OR FOR, THE BENEFIT OF, UNITED STATES PERSONS. THIS TERM SHEET MAY NOT BE DISTRIBUTED IN THE UNITED STATES.

SUMMARY TERMS

THIS TERM SHEET IS A NON-BINDING SUMMARY OF THE ECONOMIC TERMS AND DOES NOT PURPORT TO BE EXHAUSTIVE. THE BINDING TERMS AND CONDITIONS WILL BE SET OUT IN THE PRICING SUPPLEMENT WHICH AMENDS AND SUPPLEMENTS THE TERMS AND CONDITIONS IN THE OFFERING CIRCULAR. INVESTORS MUST READ ALL OF THESE DOCUMENTS AND COPIES ARE AVAILABLE FROM THE ISSUER AND THE ISSUE AND PAYING AGENT.

- The Risk Factors set out in the Offering Circular and this Term Sheet highlight some, but not all, of the risks of investing in this investment product.
- The Issuer makes no representations as to the suitability of this investment product for any particular investor nor as to the future performance of this investment product.
- Prior to making any investment decision, investors should satisfy themselves that they fully understand the risks relating to this investment product and seek professional advice as they deem necessary.

SUMMARY DESCRIPTION

The product is issued as Notes in USD and aims to pay conditional coupons on a periodic basis for the life of the Securities. Whether or not the coupons are payable will be determined based on the performance of each Basket Constituent, as described below. The Securities have an early redemption feature whereby, depending on the performance of each Basket Constituent which is evaluated on a periodic basis, the Securities may redeem early and Securityholders will receive 100% of the Calculation Amount in such circumstance.

If the Securities have not redeemed early, the amount payable at maturity for each Note (the "**Redemption Amount**") will be determined by reference to the price of the Worst Performing Basket Constituent on the Final Valuation Date. Therefore, the Redemption Amount will be either a cash amount equal to 100% of the Calculation Amount or a cash amount determined by reference to the performance of the Worst Performing Basket Constituent, as described below.

PRODUCT DETAILS

Issuer	Barclays Bank PLC ("**Barclays**")
Type of Security	Note
Issue Currency	United States Dollar ("**USD**")
Aggregate Nominal Amount	USD 2,000,000
Specified Denomination	USD 1,000
Minimum Tradable Amount	USD 1,000 (and USD 1,000 thereafter)
	During the life of the Securities, there may be no sales or partial redemptions of Securities in amounts less than the Minimum Tradable Amount.
Calculation Amount per Security	USD 1,000
Issue Price	100.00% of par
	The Issue Price relates to the Securities the Issuer sells initially on the Trade Date. The Issuer may decide, after the Trade Date, to issue additional Securities that will become immediately fungible, when issued, with the Securities described in this Term Sheet. Any such securities may be sold at varying prices to be determined at the time of each sale, which may be at market prices prevailing, at prices related to such prevailing prices or at negotiated prices.
Trade Date	12 August 2015
Issue Date	19 August 2015

Redemption Date	19 February 2019
Reference Assets	A basket comprised of 1 Equity Index and 1 ETF, each of which is set out in the Appendix (each, a "**Basket Constituent**" and together, the "**Basket of Equities**"). Any Basket Constituent stated as being an "**Index**" represents a notional investment in such index with a notional investment size of 1 Reference Asset Currency per index point. Any Basket Constituent stated as being an "**ETF**" is an Exchange Traded Fund, which is a "**Share**" for the purposes of this Security.
Settlement Method	Cash
Settlement Currency	USD

INTEREST

Interest (coupon(s))	Provided that a Specified Early Redemption Event has not occurred prior to the relevant Interest Valuation Date, as determined by the Determination Agent, in respect of the relevant Interest Payment Date:
	(i) If the Valuation Price of each Basket Constituent on the relevant Interest Valuation Date is at or above its Interest Barrier:
	2.00% x Calculation Amount; or
	(ii) Otherwise, zero.
	Where:
	"**Interest Barrier**" means, in respect of a Basket Constituent, 70% of the Initial Price of that Basket Constituent, as specified in the Appendix.
	"**Initial Price**" means, in respect of a Basket Constituent, the price of that Basket Constituent at the Valuation Time on the Initial Valuation Date as specified in the Appendix.
Interest Valuation Dates	Each date set out in the table below in the column entitled "Interest Valuation Dates".

Interest Valuation Date(s)	Interest Payment Date(s)
12 November 2015	19 November 2015
12 February 2016	22 February 2016
12 May 2016	19 May 2016
12 August 2016	19 August 2016
14 November 2016	21 November 2016
13 February 2017	21 February 2017
12 May 2017	19 May 2017
14 August 2017	21 August 2017
13 November 2017	20 November 2017
12 February 2018	20 February 2018
14 May 2018	21 May 2018
13 August 2018	20 August 2018
12 November 2018	19 November 2018
11 February 2019	19 February 2019

Interest Payment Dates	Each date set out in the table above in the column entitled "Interest Payment Dates".

REDEMPTION

Final Cash Settlement Amount	Provided that no event that may lead to the early redemption or termination of the Securities has occurred prior to the Redemption Date as determined by the Determination Agent, on the Redemption Date, each Security will be redeemed by the Issuer at a cash amount determined by the Determination Agent in accordance with the following:
	(a) If, in respect of the Worst Performing Basket Constituent, the Valuation Price on the Final Valuation Date is at or above the relevant Knock-in Barrier Price, a cash amount equal to the Calculation Amount; or

(b) If, in respect of the Worst Performing Basket Constituent, the Valuation Price on the Final Valuation Date is below the relevant Knock-In Barrier Price, a cash amount equal to the Calculation Amount multiplied by the Valuation Price of the Worst Performing Basket Constituent on the Final Valuation Date and divided by the Strike Price of the Worst Performing Basket Constituent.

Where:

"**Knock-in Barrier Price**" means, in respect of a Basket Constituent, 70% of the Initial Price of that Basket Constituent, as specified in the Appendix.

"**Strike Price**" means, in respect of a Basket Constituent, 100.00% of the Initial Price of that Basket Constituent as specified in the Appendix.

"**Initial Price**" means, in respect of a Basket Constituent, the price of that Basket Constituent at the Valuation Time on the Initial Valuation Date as specified in the Appendix.

"**Initial Valuation Date**" means 12 August 2015.

"**Valuation Price**" means, in respect of a Valuation Date and any relevant Scheduled Trading Day, the price of the Basket Constituent at the Valuation Time on such day, as determined by the Determination Agent.

"**Final Valuation Date**" means 11 February 2019.

"**Valuation Time**" means in respect of each Basket Constituent which is an Index the time at which the official level of the Index is calculated and published by the Index Sponsor; for all other Basket Constituents the time at which the official closing price of the Basket Constituent is published by the relevant Exchange.

"**Worst Performing Basket Constituent**" means the Basket Constituent with the lowest performance calculated as follows:

$$\frac{V_{(i)Final}}{V_{(i)Initial}}$$

Where:

$V_{(i)Final}$ is the Valuation Price of Basket Constituent$_i$ on the Final Valuation Date.

$V_{(i)Initial}$ is the Initial Price of Basket Constituent$_i$

Provided that where more than one Basket Constituent has the same lowest performance, the Determination Agent shall in its sole discretion select which of the Basket Constituents with the same lowest performance shall be the Worst Performing Basket Constituent.

EARLY REDEMPTION FOLLOWING A SPECIFIED EARLY REDEMPTION EVENT

Specified Early Redemption Event

Applicable, and Automatic Early Redemption Applicable.

If the Valuation Price of each Basket Constituent on any Autocall Valuation Date is at or above its respective Autocall Barrier, the Issuer shall notify the Securityholder upon the occurrence of such event and shall redeem all of the Securities (in whole only) early at the Specified Early Cash Settlement Amount on the Specified Early Cash Redemption Date.

Where:

"**Autocall Barrier**" means, in respect of a Basket Constituent, 100.00% of the Initial Price of that Basket Constituent, as specified in the Appendix.

"**Initial Price**" means, in respect of a Basket Constituent, the price of that Basket Constituent at the Valuation Time on the Initial Valuation Date as specified in the Appendix.

"**Autocall Valuation Date**" means each date set out in the table below in the column entitled "Autocall Valuation Dates".

Autocall Valuation Date(s)	Specified Early Cash Redemption Date(s)
12 November 2015	19 November 2015
12 February 2016	22 February 2016
12 May 2016	19 May 2016
12 August 2016	19 August 2016
14 November 2016	21 November 2016
13 February 2017	21 February 2017
12 May 2017	19 May 2017
14 August 2017	21 August 2017

13 November 2017	20 November 2017
12 February 2018	20 February 2018
14 May 2018	21 May 2018
13 August 2018	20 August 2018
12 November 2018	19 November 2018

Specified Early Cash Settlement Amount   In respect of each Security, the Calculation Amount.

Specified Early Cash Redemption Date   Each date set out in the table above in the column entitled "Specified Early Cash Redemption Dates".

Valuation Date   The Initial Valuation Date, Final Valuation Date, each Interest Valuation Date and each Autocall Valuation Date.

ADDITIONAL DISRUPTION EVENT AND ADJUSTMENT OR EARLY REDEMPTION

Additional Disruption Event   The Issuer may either (i) require the Determination Agent to make an adjustment to the terms of the Securities or (ii) on giving not less than 10 Business Days notice to the Securityholders, redeem all of the Securities early at the Early Cash Settlement Amount on the Early Cash Redemption Date if any of the following events occur:

Change in Law, Currency Disruption Event, Issuer Tax Event, Extraordinary Market Disruption, Hedging Disruption

Other Additional Disruption Event(s) in respect of Share Linked Securities   Insolvency Filing, Merger Event, Nationalisation, Insolvency, Delisting, Tender Offer, Fund Disruption Event

Other Additional Disruption Event(s) in respect of Index Linked Securities   Index Adjustment Event - provided that an Index Adjustment Event shall only constitute an Additional Disruption Event if the Determination Agent determines that it can no longer continue to calculate such Index.

Delay or Postponement of Payments and Settlement   If the determination of a price or level used to calculate any amount payable or deliverable on any payment or settlement date is delayed or postponed pursuant to the terms and conditions of the Securities,payment or settlement will occur on the later of either (i) the scheduled payment or settlement date or (ii) the second Business Day following the date on which such price or level is determined. No additional amounts shall be payable or deliverable by the Issuer because of such postponement.

If the date on which any amount is specified as being(or is otherwise determined to be) payable in respect of any Security is not a Business Day then payment will not be made until the next succeeding day which is a Business Day, and the holder thereof shall not be entitled to any further payment in respect of such delay.

Substitution of Shares   Substitution of Shares – ETF underlying is applicable. If any Share is affected by a Fund Disruption Event, Merger Event, Tender Offer, Nationalisation, Insolvency Filing, Insolvency or Delisting, or if the Share is cancelled or there is an announcement for it to be cancelled then, in addition to the Issuer's right to adjust or redeem the Securities, the Issuer or the Determination Agent has the discretion to substitute such Shares with shares, units or other interests of an exchange-traded fund or other financial security, index or instrument (each a "**Replacement Security**") that the Determination Agent determines is comparable to the discontinued Share (or discontinued Replacement Security). Upon substitution of a Replacement Security, the Determination Agent may adjust any variable in the terms of the Securities (including, without limitation, any variable relating to the price of the shares, units or other interests in the Share, the number of such shares, units or other interests outstanding, created or redeemed or any dividend or other distribution made in respect of such shares, units or other interests), as, in the good faith judgment of the Determination Agent, may be and for such time as may be necessary to render the Replacement Security comparable to the shares or other interests of the discontinued Share (or discontinued Replacement Security). The Determination Agent shall notify the Securityholders as soon as practicable after the selection of the Replacement Security.

Adjustments and Early Redemption   **Successor Index Sponsor and Successor Index:** In respect of an Equity Index, in the event that the Index Sponsor ceases to calculate and announce the Index but the Index is calculated and announced by a successor index sponsor or the Index is replaced by a successor index which is the same as, or substantially similar to the Index (as determined by the Determination Agent), the level of the Index will be determined with reference to the calculations of the successor index sponsor or the level of that successor index.

Index Adjustment Events: In respect of an Equity Index, if there occurs an Index Modification, Index Cancellation or Index Disruption (each an "**Index Adjustment Event**"), the Determination Agent may (i) calculate the level of the Index using the formula for and method of calculating the Index last in effect prior to the Index Adjustment Event, or (ii) if the Determination Agent determines that it can no longer continue to calculate the level of the Index, deem such Index Adjustment Event to constitute an Additional Disruption Event and the Issuer may either (x) require the Determination Agent to make an adjustment to the terms of the Securities, or (y) redeem all of the Securities at the Early Cash Settlement Amount on the Early Cash Redemption Date.

Potential Adjustment Event: In respect of Shares, if (i) there occurs a subdivision, consolidation or reclassification of the Share, or (ii) a distribution, dividend, extraordinary dividend, repurchase of the Shares or similar corporate action is declared by the Share Company (each, a "**Potential Adjustment Event**"), in any case that the Determination Agent determines has a diluting or concentrative effect on the theoretical value of the Share, (x) the Determination Agent may make an adjustment to the Share, any amounts payable under the Securities and/or any of the other terms of the Securities, taking into account any costs incurred by or on behalf of the Issuer as a resultof such Potential Adjustment Event,as determined in good faith by the Determination Agent, or (y) the Issuer may deliver to the Securityholder one or more additional Securities and/or pay to the Securityholder a cash amount, which aggregate value shall be equal to the value of the concentrative effect of such Potential Adjustment Event on the theoretical value of the relevant Shares.

Early Cash Settlement Amount	An amount per Calculation Amount in the Settlement Currency determined as the pro rata proportion of the market value of the Securities following the event triggering the early redemption or cancellation (including the value of accrued interest (if applicable)). Such amount shall be determined as soon as reasonably practicable following the event giving rise to the early redemption or cancellation of the Securities by reference to such factors as the Determination Agent considers to be appropriate including, without limitation:
	(a) market prices or values for the reference asset(s) and other relevant economic variables (such as interest rates and, if applicable, exchange rates) at the relevant time;
	(b) the remaining term of the Securities had they remained outstanding to scheduled maturity or expiry and/or any scheduled early redemption or exercise date;
	(c) the value at the relevant time of any minimum redemption or cancellation amount which would have been payable had the Securities remained outstanding to scheduled maturity or expiry and/or any scheduled early redemption or exercise date;
	(d) internal pricing models; and
	(e) prices at which other market participants might bid for securities similar to the Securities,
	provided that the Determination Agent may adjust such amount to take into account deductions for any costs, charges, fees, accruals, losses, withholdings and expenses, which are or will be incurred by the Issuer or its Affiliates in connection with the unwinding of any Hedge Positions and/or related funding arrangements, when determining such market value.
	"**Affiliate**" means, in relation to any entity (the "**First Entity**"), any entity controlled, directly or indirectly, by the First Entity, any entity that controls, directly or indirectly, the First Entity or any entity, directly or indirectly, under common control with the First Entity. For these purposes, "control" means ownership of a majority of the voting power of an entity.
	"**Hedge Positions**" means any purchase, sale, entry into or maintenance of one or more (a) positions or contracts in securities, options, futures, derivatives or foreign exchange, (b) stock loan transactions or (c) other instruments or arrangements (howsoever described) by the Issuer or any of its Affiliates in order to hedge individually, or on a portfolio basis, the Issuer's obligations in respect of the Securities.
Early Cash Redemption Date	In respect of an early redemption following an Additional Disruption Event, the 10th Business Day after the giving of the redemption notice by or on behalf of the Issuer or the Determination Agent to the Securityholders.

OTHER TERMS

Disruption	In respect of Shares in a Basket, in the event that any Valuation Date is a Disrupted Day (as described in the Offering Circular) in relation to each Share affected by the occurrence of a Disrupted Day (each an "**Affected Share**"), the relevant valuation will be postponed for up to eight Scheduled Trading Days. After this time, (1) the eighth Scheduled Trading Day shall be deemed to be the Valuation Date; and (2) the Determination Agent will make the relevant determination by estimating the price of the Affected Share that would have prevailed on such eighth Scheduled Trading Day. In respect of each Share not affected by the occurrence of a Disrupted Day, the Valuation Date shall be the Scheduled Valuation Date.
	In respect of an Equity Index in a Basket, in the event that any Valuation Date is a Disrupted Day (as described in the Offering Circular), in relation to each Index affected by the occurrence of a Disrupted Day (each an "**Affected Index**"), the relevant valuation in respect of such Affected Indices will be postponed for up to eight Scheduled Trading Days. After this time, (1) the eighth Scheduled Trading Day shall be deemed to be the Valuation Date; and (2) the Determination Agent shall determine the level of the Affected Indices using the level of the index set out in the applicable Pricing Supplement, or in the event that no index level is provided in the Pricing Supplement, by using the index level on the eighth Scheduled Trading Day determined in accordance with the formula and method of calculating that Index in effect immediately prior to the occurrence of first Disrupted Day using the Exchange traded or quoted price on the eighth Scheduled Trading Day of each component of that Index. In respect of each Index that is not affected by the occurrence of a Disrupted Date, the Valuation Date shall be the Scheduled Valuation Date.
Unlawfulness and impracticability	If the Issuer determines that the performance of any of its obligations under the Securities has become, or there is a substantial likelihood that it will become, unlawful or impracticable, in whole or in part, as a result of (i) any change in financial, political or economic conditions or currency exchange rates, or (ii) compliance in good faith by the Issuer or any relevant subsidiaries or Affiliates with any applicable present or future law, rule, regulation, judgement, order or directive of any governmental, administrative or judicial authority or power or in interpretation thereof, the Issuer may, as its option, redeem or cancel the Securities by giving notice to Securityholders.
	If the Issuer elects to redeem or cancel the Securities, then each Security shall become due and payable at its Early Cash Settlement Amount.
Notices	The Issuer or Determination Agent shall give notice to the Securityholders of any adjustment or redemption as soon as practicable following the occurrence of the event triggering such adjustment or redemption. Failure by the Issuer or Determination Agent to publish or give notice shall not affect the validity or effectiveness of any such adjustment or redemption.

GENERAL INFORMATION

Programme	Barclays Bank PLC Global Structured Securities Programme
Offering Circular	Offering Circular dated 24 June 2015 pursuant to the Programme. The Offering Circular is available at:

REGULATORY REVIEW AND IMPORTANT INFORMATION FOR PROSPECTIVE INVESTORS:

THE OFFERING CIRCULAR HAS NOT BEEN SUBMITTED TO, REVIEWED BY OR APPROVED BY THE UNITED KINGDOM FINANCIAL CONDUCT AUTHORITY IN ITS CAPACITY AS COMPETENT AUTHORITY UNDER THE FINANCIAL SERVICES AND MARKETS ACT 2000 (THE "FSMA") OR ANY OTHER REGULATORY AUTHORITY IN ITS CAPACITY AS COMPETENT AUTHORITY IN THE EU OR THE LONDON STOCK EXCHANGE PLC OR ANY OTHER STOCK EXCHANGE WHICH CONSTITUTES A REGULATED MARKET FOR THE PURPOSES OF DIRECTIVE 2004/39/EC (THE "MARKETS IN FINANCIAL INSTRUMENTS DIRECTIVE").

THIS MEANS THAT THE OFFERING CIRCULAR DOES NOT COMPRISE (I) A BASE PROSPECTUS FOR THE PURPOSES OF ARTICLE 5.4 OF DIRECTIVE 2003/71/EC (AND AMENDMENTS THERETO) (THE "PROSPECTUS DIRECTIVE") OR ANY UK OR OTHER IMPLEMENTING LEGISLATION RELATED TO THE PROSPECTUS DIRECTIVE, OR (II) LISTING PARTICULARS FOR THE PURPOSES OF SECTION 79 OF THE FSMA OR ANY OTHER RULES OR REGULATIONS RELATED TO A LISTING ON ANY REGULATED MARKET OF ANY STOCK EXCHANGE.

Relevant Annex	Equity Linked Annex
Issuer Rating (Long Term)	As of the date of this Term Sheet, A2/A-/A (Moody's/S&P/Fitch)
Status	Unsecured and Unsubordinated
Form	Global Bearer Securities: Permanent Global Security
	Classic Global Note (CGN)
Manager	Barclays Bank PLC
Issue and Paying Agent	The Bank of New York Mellon
Business Days	With regard to payments: London, New York City and a Clearing System Business Day.
Business Day Convention	With regard to all payment dates in this Term Sheet, unless otherwise specified: Modified Following
Listing and Admission to Trading	None
Determination Agent	Barclays Bank PLC
Relevant Clearing Systems	Euroclear
	Clearstream
Governing Law	English Law
Jurisdiction	Courts of England
Documentation	The full terms and conditions of the Securities (including Terms used but not defined in this Term Sheet) will be set out in the Offering Circular as supplemented and amended by the Pricing Supplement.

SELLING RESTRICTIONS AND TAX

Selling Restrictions

Investors are bound by all applicable laws and regulations of the relevant jurisdiction(s) in which the Securities are to be offered, sold and distributed, including the selling restrictions set out in this document and the Offering Circular. Investors in this Product should seek specific advice before on-selling this Product.

No action has been made or will be taken by the Issuer that would permit a public offering of the Securities or possession or distribution of any offering material in relation to the Securities in any jurisdiction where action for that purpose is required. Each purchaser or distributor of the Securities represents and agrees that it will not purchase, offer, sell, re-sell or deliver the Securities or, have in its possession or distribute, the Offering Circular, any other offering material or any Pricing Supplement, in any jurisdiction except in compliance with the applicable laws and regulations of such jurisdiction and in a manner that will not impose any obligation on the Issuer or Manager (as the case may be).

Tax

An outline of certain tax consequences of investing in the Securities may be given in the Offering Circular. The relevant tax laws and the regulations of the tax authorities are subject to change. You should consult with your tax advisors regarding the purchase, holding or disposition of the Securities.

Third Party Fees

The Issue Price for any Securities (whether issued on or after the Issue Date) includes a commission element shared with a third party, which will not exceed 1.65% of the Calculation Amount per Security. Further details of the commission element are available upon request.

RISK FACTORS

THESE RISK FACTORS HIGHLIGHT ONLY SOME OF THE RISKS OF THE PRODUCT DESCRIBED IN THIS DOCUMENT (THE "PRODUCT") AND MUST BE READ IN CONJUNCTION WITH THE RISK FACTOR SECTIONS IN THE OFFERING CIRCULAR. INVESTORS MUST BE CAPABLE OF ASSESSING AND UNDERSTANDING THE RISKS OF INVESTING IN THE PRODUCT. WHERE A POTENTIAL INVESTOR DOES NOT UNDERSTAND OR WOULD LIKE FURTHER INFORMATION ON THE RISKS OF THE PRODUCT, THE POTENTIAL INVESTOR SHOULD SEEK PROFESSIONAL ADVICE BEFORE MAKING ANY INVESTMENT DECISION.

NO GOVERNMENT OR OTHER PROTECTION

THIS PRODUCT IS NOT PROTECTED BY THE FINANCIAL SERVICES COMPENSATION SCHEME or any other government or private protection scheme.

BARCLAYS FINANCIAL STANDING	INVESTORS ARE EXPOSED TO BARCLAYS' FINANCIAL STANDING. If Barclays becomes insolvent, Barclays may not be able to make any payments under the Product and investors may lose their capital invested in the Product. A decline in Barclays' financial standing is likely to reduce the market value of the Product and therefore the price an investor may receive for the Product if they sell it in the market.
CREDIT RATINGS	CREDIT RATINGS MAY BE LOWERED OR WITHDRAWN WITHOUT NOTICE. A rating is not a recommendation as to Barclays' financial standing or an evaluation of the risks of the Product.
VOLATILITY	THE PERFORMANCE OF THIS PRODUCT MAY CHANGE UNPREDICTABLY.This unpredictable change is known as "volatility" and may be influenced by the performance of any underlying asset as well as external factors including financial, political and economic events and other market conditions.
CAPITAL AT RISK	THE CAPITAL INVESTED IN THIS PRODUCT IS AT RISK. Investors may receive back less than the capital invested in the Product.
CAPITAL AT RISK ON EARLY REDEMPTION	THE PRODUCT MAY BE REDEEMED BEFORE ITS SCHEDULED MATURITY DATE. IF THE PRODUCT IS REDEEMED EARLY, INVESTORS MAY RECEIVE BACK LESS THAN THEIR ORIGINAL INVESTMENT IN THE PRODUCT, OR EVEN ZERO. The amount payable to an investor on an early redemption may factor in Barclays' costs of terminating hedging and funding arrangements associated with the Product.
SELLING RISK	AN INVESTOR MAY NOT BE ABLE TO FIND A BUYER FOR THE PRODUCT SHOULD THE INVESTOR WISH TO SELL THE PRODUCT. If a buyer can be found, the price offered by that buyer may be lower than the price that an investor paid for the Product or the amount an investor would otherwise receive at the maturity of the Product.
OVER-ISSUANCE	THE ISSUER MAY ISSUE MORE SECURITIES THAN THOSE WHICH ARE TO BE INITIALLY SUBSCRIBED OR PURCHASED BY INVESTORS. The Issuer (or the Issuer's affiliates) may hold such Securities for the purpose of meeting any future investor interest or to satisfy market making requirements. Prospective investors in the Securities should not regard the issue size of any Series as indicative of the depth or liquidity of the market for such Series or of the demand for such Series.
NO INVESTMENT IN OR RIGHTS TO UNDERLYING ASSETS	AN INVESTMENT IN THE PRODUCT IS NOT THE SAME AS AN INVESTMENT IN THE UNDERLYING ASSETS REFERENCED BY THE PRODUCT. An investor in the Product has no ownership of, or rights to, the underlying assets referenced by the Product. The market value of the Product may not reflect movements in the price of such underlying assets. Payments made under the Product may differ from payments made under the underlying assets.
ADJUSTMENTS	THE TERMS OF THE PRODUCT MAY BE ADJUSTED BY BARCLAYS UPON CERTAIN EVENTS TAKING PLACE WHICH IMPACT THE UNDERLYING ASSETS, INCLUDING MARKET DISRUPTION EVENTS.
SMALL HOLDINGS	SMALL HOLDINGS MAY NOT BE TRANSFERABLE. Where the Product terms specify a minimum tradable amount, investors will not be able to sell the Product unless they hold at least such minimum tradable amount.
INTEREST RATE RISK	INVESTORS IN THE PRODUCT WILL BE EXPOSED TO INTEREST RATE RISK. Changes in interest rates will affect the performance and value of the Product. Interest rates may change suddenly and unpredictably.
PAYMENTS	PAYMENTS FROM BARCLAYS MAY BE SUBJECT TO DEDUCTIONS FOR TAX, DUTY, WITHHOLDING OR OTHER PAYMENTS REQUIRED BY LAW.
OTHER RISKS	THIS DOCUMENT CANNOT DISCLOSE ALL POSSIBLE RISKS OF THE PRODUCT. Before investing, investors must be satisfied that they have sufficient information and understand the risks related to the Product so as to make an informed investment decision. If investors are uncertain as to whether they have sufficient information, they should seek independent professional advice before investing.
FOREIGN EXCHANGE RISK	INVESTORS ARE EXPOSED TO FOREIGN EXCHANGE RISK. Foreign exchange rates may change suddenly and unpredictably. Changes in the exchange rate between an investor's home currency and the Product currency or settlement currency may impact the performance of the Product and an investor's return.
LEVERAGE	THIS PRODUCT MAY BECOME LEVERAGED. Leverage increases the investor's exposure to the underlying assets referenced by the Product and amplifies the investor's losses and gains.
INTERACTION RISK	THIS PRODUCT COMBINES DIFFERENT FINANCIAL COMPONENTS AND EXPOSURES WHICH MAY INTERACT UNPREDICTABLY AND COULD AFFECT THE PERFORMACE OF THE PRODUCT.
PERFORMANCE OF SHARE INDICES	THE PERFORMANCE OF SHARES IN AN INDEX IS UNPREDICTABLE. It depends on financial, political, economic and other events as well as the share issuers' earnings, market position, risk situation, shareholder structure and distribution policy.
INDEX RETURN	AN INDEX RETURN MAY BE LOWER THAN THE ACTUAL RETURN ON THE COMPONENTS COMPRISING SUCH INDEX. Indices may deduct fees, costs and commissions. An investment in an index may be taxed differently to a direct investment in the components of the index.
ADJUSTMENTS, SUSPENSION AND TERMINATION OF AN INDEX	THE INDEX SPONSOR MAY ADJUST THE COMPOSITION OR CALCULATION METHODOLOGY OF AN INDEX AND MAY CANCEL, ADJUST OR SUSPEND AN INDEX. Such actions may negatively affect the value and performance of the Product.
INDEX SUBSTITUTION	AN INDEX MAY BE REPLACED WITH ANOTHER INDEX IN CERTAIN CIRCUMSTANCES. Such action may negatively affect the value and performance of the Product.
TRACKING RISK	There may be a difference between the performance of the underlying ETF and the performance of the asset pool or index that the ETF is designed to track as a result of, for example, failure of the tracking strategy, currency differences, fees and expenses.
DERIVATIVE RISK	The ETF may invest in financial derivative instruments which expose the ETF and an investor to the credit, liquidity and concentration risks of the counterparties to such financial derivative instruments.
PERFORMANCE OF AN ETF	THE PERFORMANCE OF SHARES IN AN ETF IS UNPREDICTABLE. It depends on financial, political, economic and other events as well as the ETF's earnings, market position, risk situation, shareholder structure and distribution policy.
ETF ISSUER ACTION	THE ETF ISSUER IS NOT INVOLVED IN THE PRODUCT. The ETF Issuer may take actions that adversely affect the value and performance of the Product.

INTEREST PAYMENTS	YOU MAY NOT RECEIVE ANY INTEREST PAYMENTS. Barclays will not necessarily make interest payments under the terms of the Product. If the Valuation Price of at least one of the Basket Constituents on the relevant Interest Valuation Date is less than the Interest Barrier, Barclays will not make the interest payment applicable to such Interest Valuation Date. If the Valuation Price of at least one of the Basket Constituents is less than the Interest Barrier on each of the Interest Valuation Dates, Barclays will not make any interest payments during the term of the Product, and you will not receive a positive return on your initial investment.
POTENTIAL EARLY EXIT /REINVESTMENT RISK	There is no guarantee that you would be able to reinvest the proceeds from an investment in the Product in a comparable investment with a similar level of risk in the event the Securities are called prior to the Redemption Date.
POTENTIAL RETURN LIMITED	The return potential of the Securities is limited to the interest payments based on the pre-specified interest rate, regardless of the appreciation of the Basket Constituents. In addition, the total return on the Securities will vary based on the number of Interest Valuation Dates on which the Valuation Price of each Basket Constituent has equaled or exceeded its respective Interest Barrier price prior to the Redemption Date or a Specified Early Redemption Event. Further, if the Securities are called due to a Specified Early Redemption Event, you will not receive any interest payments in respect of any Interest Valuation Dates after the applicable Specified Early Redemption Date. Because the Securities could be called as early as the first Autocall Valuation Date, the total return on the Securities could be minimal. If the Valuation Price of the Worst Performing Basket Constituent on the Final Valuation Date is below its Knock-in Barrier Price and no event that may lead to the early redemption or termination of the Securities has occurred prior to the Redemption Date as determined by the Determination Agent, the Securities will be fully exposed to the decline in the price of the Worst Performing Basket Constituent and a Securityholder will lose some or all of their principal investment in the Securities.

DISCLAIMER

CONFLICT OF INTERESTS	BARCLAYS IS A FULL SERVICE INVESTMENT BANK. In the normal course of offering investment banking products and services to clients, Barclays may act in several capacities (including issuer, market maker, underwriter, distributor, index sponsor, swap counterparty and calculation agent) simultaneously with respect to a Product, giving rise to potential conflict of interests which may impact the performance of a Product.
BARCLAYS POSITIONS	Barclays, its affiliates and associated personnel may at any time acquire, hold or dispose of long or short positions (including hedging and trading positions) which may impact the performance of a Product.
PRIVATE INFORMATION	BARCLAYS MAY HAVE PRIVATE INFORMATION ABOUT ANY PRODUCT AND/OR THE UNDERLYING ASSETS REFERENCED BY THE PRODUCT. It is not obligated to disclose any such information to investors or counterparties.
FOR INFORMATION ONLY	THIS DOCUMENT IS PROVIDED FOR INFORMATION PURPOSES ONLY AND IS SUBJECT TO CHANGE. IT IS INDICATIVE ONLY AND IS NOT BINDING.
NO OFFER	Barclays is not offering to sell or seeking to buy any Product or enter into any transaction. Any transaction requires Barclays' formal agreement which will be subject to internal approvals and binding transaction documents.
NO LIABILITY	Barclays is not responsible for the use made of this document other than the purpose for which it is intended, except to the extent this would be prohibited by law or regulation.
NO ADVICE	OBTAIN INDEPENDENT PROFESSIONAL ADVICE BEFORE INVESTING OR TRANSACTING. Barclays is not an advisor and will not provide any advice relating to a Product. Before making an investment decision, investors and counterparties should ensure they have sufficient information to ascertain the legal, financial, tax and regulatory consequences of an investment to enable them to make an informed investment decision.
THIRD PARTY INFORMATION	Barclays is not responsible for information stated to be obtained or derived from third party sources or statistical services.
DISTRIBUTION	All laws and regulations in any relevant jurisdiction(s) must be complied with when offering, marketing or selling a Product or distributing offering materials.
PAST & SIMULATED PAST PERFORMANCE	Any past or simulated past performance (including back-testing) contained in this document is no indication as to future performance.
OPINIONS SUBJECT TO CHANGE	All opinions and estimates are given as of the date hereof and are subject to change. Barclays is not obliged to inform investors and counterparties of any change to such opinions or estimates.
REGULATORY DISCLOSURE	Information relating to an investment may be disclosed when required by regulators or other authorities, including tax authorities.
TAX DISCLOSURE	All discussions and any related materials relating to the tax treatment or tax structure of any transactions described in this document (including any attachments) may be disclosed without limitation. This authorisation of tax disclosure supersedes anything to the contrary contained in this document or otherwise communicated.
CONFIDENTIAL	This document is confidential and no part of it may be reproduced, distributed or transmitted without the prior written permission of Barclays.
ABOUT BARCLAYS	Barclays offers premier investment banking products and services to its clients through Barclays Bank PLC. Barclays Bank PLC is authorised by the Prudential Regulation Authority and regulated by the Financial Conduct Authority and the Prudential Regulation Authority. Barclays Bank PLC is a member of the London Stock Exchange. Barclays Bank PLC is registered in England No. 1026167. Registered Office: 1 Churchill Place, London E14 5HP.
COPYRIGHT	Copyright Barclays Bank PLC, 2015 (all rights reserved).

i	Basket Constituent	Type	Bloomberg Code (for identification purposes only)	ISIN/Index Sponsor	Exchange	Related Exchange	Reference Asset Currency	Initial Price	Strike Price (100.00% of Initial Price displayed to 4 d.p.)	Interest Barrier (70.00% of Initial Price displayed to 4.d.p.)	Autocall Barrier (100.00% of Initial Price displayed to 4.d.p.)	Knock-in Barrier Price (70.00% of Initial Price displayed to 4 d.p.)
1	WISDOMTREE INDIA EARNINGS	ETF	EPI UP	US97717W4226	NYSE Arca	All Exchanges	USD	21.19	21.1900	14.8330	21.1900	14.8330
2	Euro Stoxx 50® Index	Index	SX5E	Stoxx Ltd.	Multi-exchange	All Exchanges	EUR	3,484.41	3,484.4100	2,439.0870	3,484.4100	2,439.0870

"**Multi-exchange**" means, in respect of each component security of the Index (each, a "**Component Security**"), the stock exchange on which such Component Security is principally traded, as determined by the Determination Agent.

Table 7: Summary Statistics of T-Maturity Asset Returns

Maturity in Year	1	2	3	5	∞
UKX (Apr 2004 - Jan 2017, NObs = 154)					
Mean (%)	0.9068	1.2111	1.2112	0.8039	0.3705
Stdev (%)	3.8493	4.3114	5.1841	5.2137	3.7047
Sharpe Ratio	0.2356	0.2809	0.2337	0.1542	0.0990
KOSPI2 (Apr 2004 - Jan 2017, NObs = 154)					
Mean (%)	1.0253	0.9974	1.0749	1.4144	0.7730
Stdev (%)	20.1911	13.8770	12.5844	14.0654	4.8757
Sharpe Ratio	0.0508	0.0788	0.0854	0.1006	0.1585
HSI (Nov 2004 - Jan 2017, NObs = 147)					
Mean (%)	0.6719	0.3532	0.1982	0.3018	0.8219
Stdev (%)	8.7169	6.9001	6.9189	6.9367	6.1261
Sharpe Ratio	0.0771	0.0512	0.0287	0.0435	0.1342
HSCEI (Jan 2005 - Nov 2013, NObs = 107)					
Mean (%)	1.2964	1.2203	1.2856	1.4242	1.2507
Stdev (%)	5.6395	5.5930	5.9390	6.6023	9.1358
Sharpe Ratio	0.2299	0.2182	0.2165	0.2157	0.1380

Notes: Monthly data from the synthetic forward method (except for HSCEI, which uses the dividend future and swap method). NObs represents the total number of observation.

F   Mathematical Proof

F.1   Proof of lemma 2

Assume the following (Feller-like) conditions on (R_t^e, X):

- q, X have compact supports.

- For any continuous function f, $\mathbb{E}[f(R_{t+1}^e, X_{t+1}) \mid X_t = x]$ is continuous in x. This is a weak requirement on the dependence of (R_t^e, X_t) in X_t.

- R_{t+1}^e is bounded so that all expectations are well-defined.

Table 8: Regression of Excess Returns on Market Excess Returns

Maturity in Year	1	2	3	5
UKX (Apr 2004 - Jan 2017, NObs = 154)				
Alpha	0.0069***	0.0094***	0.0090***	0.0046**
	(3.1887)	(3.2251)	(6.9208)	(3.0348)
Beta	0.2835***	0.4810***	0.6319***	0.7854***
	(5.1297)	(6.2627)	(8.1120)	(9.6202)
R^2	0.0775	0.1740	0.2076	0.3172
KOSPI2 (Apr 2004 - Jan 2017, NObs = 154)				
Alpha	0.0054	0.0049	0.0046	0.0085
	(0.3268)	(0.4454)	(0.4065)	(0.6551)
Beta	0.3935	0.4614**	0.6838***	0.5812***
	(1.4947)	(2.3153)	(4.6051)	(3.9578)
R^2	0.0090	0.0261	0.0697	0.0403
HSI (Nov 2004 - Jan 2017, NObs = 147)				
Alpha	0.0037	-0.0008	-0.0031	-0.0030
	(0.4660)	(-0.1371)	(-0.5438)	(-0.5407)
Beta	0.2226	0.3721**	0.4683***	0.5855***
	(1.5021)	(2.6074)	(3.3205)	(4.0029)
R^2	0.0244	0.1091	0.1719	0.2673
HSCEI (Jan 2005 - Nov 2013, NObs = 107)				
Alpha	0.0092	0.0088	0.0087	0.0087
	(1.7232)	(1.4465)	(1.3284)	(1.2838)
Beta	0.1443	0.1736**	0.2253***	0.3492***
	(1.7415)	(2.6450)	(3.6790)	(5.3842)
R^2	0.0552	0.0801	0.1208	0.2348

Notes: Monthly data from the synthetic forward method (except for HSCEI, which uses the dividend future and swap method). NObs represents the total number of observation. t statistics using Newey-West standard error in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Consider the proposed-form of the value function $J(W_t; t, X_t) = -\frac{1}{k}e^{-k(W_t + G_t(q_t, X_t))}$.

Recall that

$$\max_{C_t, d_t, \theta_t} -\frac{1}{\gamma} e^{\gamma C} + \rho \mathbb{E}_t[J(W_{t+1}; t+1, X_{t+1})]. \tag{32}$$

Taking the first-order condition with respect to C_t yields:

$$0 = e^{-\gamma C_t} + kR_f \rho \mathbb{E}_t[J(W_{t+1}; t+1, X_{t+1})] \tag{33}$$

$$= e^{-\gamma C_t} + kR_f[J(W_t; t, x_t) + \frac{1}{\gamma} e^{-\gamma C_t}] \tag{34}$$

$$e^{-\gamma C_t} = e^{-k(W_t + G_t(q_t, X_t))}. \tag{35}$$

That is, we have equation (13). Taking the first-order conditions with respect to θ_t and d_t will yield equations (14) and (15) respectively.

For the derivation of G, first let $G(t+1, \cdot)$ be given. θ_t and d_t are given as unique solutions to equations (14) and (15).

F.2 Proof of theorem 5

Differentiating the pricing kernel yields:

$$\frac{\partial m_{t+1}^q}{\partial d_t^o} = km_{t+1}^q(p_{t+1}^o - R_f p_t^o + \frac{\partial \theta_t}{\partial d_t^o} R_{t+1}^e), \tag{36}$$

where we use the facts that $\frac{\partial G_{t+1}(q_{t+1}, X_{t+1})}{\partial d_t^o} = 0$ and $\frac{\partial p_{t+1}}{\partial d_t^o} = 0$. Differentiating (22) results in

$$0 = \mathbb{E}_t(m_{t+1}^q(p_{t+1}^o - R_f p_t^o - \frac{\partial \theta_t}{\partial d_t^o} R_{t+1}^e) R_{t+1}^e), \tag{37}$$

implying that the marginal hedge position is

$$\frac{\partial \theta_t}{\partial q_t^o} = -\frac{\partial \theta_t}{\partial d_t^o}$$

$$= -\frac{\mathbb{E}_t(m_{t+1}^q(p_{t+1}^o - R_f p_t^o) R_{t+1}^e)}{\mathbb{E}_t(m_{t+1}^q(R_{t+1}^e)^2)}$$

$$= -\frac{cov_t^q(p_{t+1}^o, R_{t+1}^e)}{var_t^q(R_{t+1}^e)}. \tag{38}$$

The price sensitivity comes from differentiating (21) as follows:

$$
\begin{aligned}
\frac{\partial p_t^n}{\partial q_t^o} &= -k\mathbb{E}_t[m_{t+1}^q(p_{t+1}^o - R_f p_t^o + \frac{\partial \theta_t}{\partial q_t^o}R_{t+1}^e)p_{t+1}^n] \\
&= -\frac{k}{R_f}\mathbb{E}_t^q[(p_{t+1}^o - R_f p_t^o - \frac{cov_t^q(p_{t+1}^o, R_{t+1}^e)}{var_t^q(R_{t+1}^e)}R_{t+1}^e)p_{t+1}^n] \\
&= -\gamma(R_f - 1)\mathbb{E}_t^q[\bar{p}_{t+1}^o \bar{p}_{t+1}^n] \\
&= -\gamma(R_f - 1)cov_t^q(\bar{p}_{t+1}^o, \bar{p}_{t+1}^n).
\end{aligned}
\tag{39}
$$

G Issuance Data
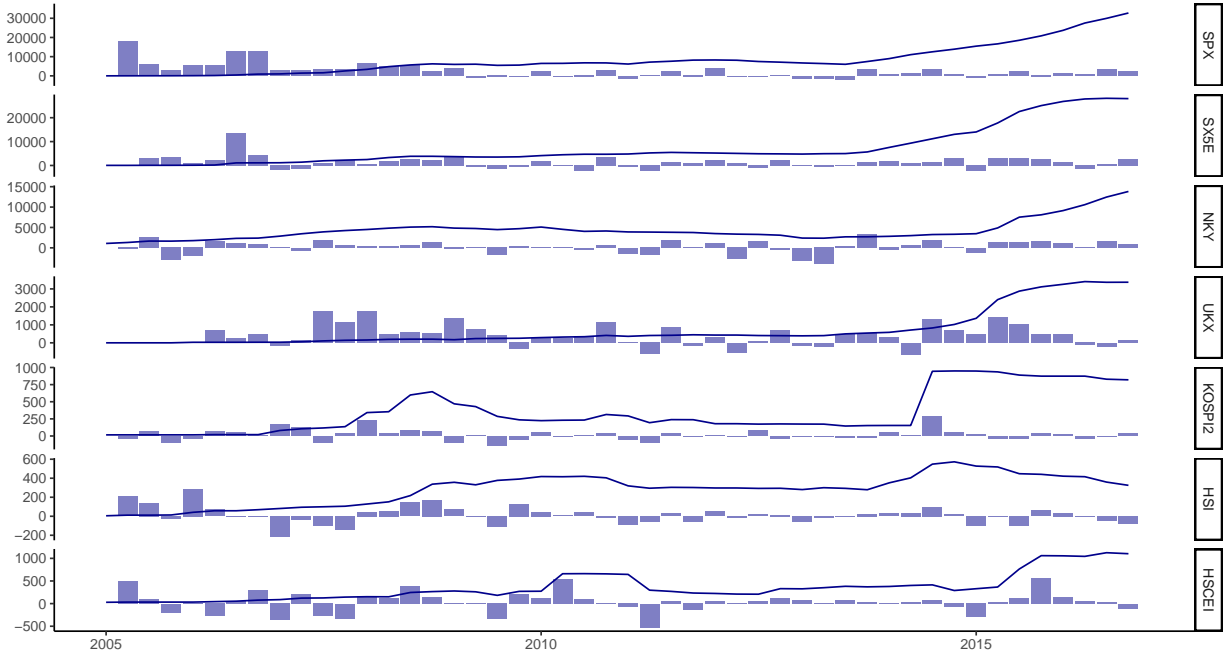
Figure 26: Notional Issuance (Million USD) associated with Each Index along with the Rescaled Quarter-by-Quarter Percentage Change in Issuance Amount

H Robustness Check on the Effect of Structured Products on T-Maturity Asset Prices

The issuance data in Figure 26 suggests the potential structural change in structured product issuance around 2014. This may be due to the fact that some of the trades before 2014 are not reported. Our data provider, mtn-i.com, confirms that pre-2014 is less comprehensive.

This section checks the robustness of our empirical results in Section 5 by dividing the sample into 2 subsamples: pre-2014 and post 2014.

Table 9: Price Regression

	T = 1		T = 2		T = 3		T = 5	
	(26)	(27)	(26)	(27)	(26)	(27)	(26)	(27)
Pre-2014								
$\Delta \log nq_t^{i,qtr}$	-13.68	-7.053	-35.64	-18.29	-58.66	-28.36	-106.9	-49.61
	(-1.05)	(-0.85)	(-1.24)	(-1.13)	(-1.28)	(-1.17)	(-1.34)	(-1.21)
$\Delta \log S_t^{i,qtr}$		121.5**		318.1***		555.4***		1050.8***
		(3.29)		(4.31)		(5.03)		(5.70)
N	247	247	247	247	247	247	247	247
Adj. R^2	0.0132	0.109	0.0211	0.175	0.0225	0.208	0.0206	0.203
Post-2014								
$\Delta \log nq_t^{i,qtr}$	-5.776	-8.552	-13.66	-11.60	-25.14	-15.77	-62.13	-34.14
	(-0.67)	(-0.89)	(-0.63)	(-0.48)	(-0.62)	(-0.35)	(-0.74)	(-0.37)
$\Delta \log S_t^{i,qtr}$		-84.88		63.11		286.7		855.7
		(-1.53)		(0.58)		(1.38)		(2.05)
N	72	72	72	72	72	72	72	72
Adj. R^2	0.0051	0.0547	0.0067	0.0132	0.0064	0.0442	0.0095	0.0909

Notes: Data from Q4 2004 - Q4 2016. Panel Regression with Fixed Effect. t statistics using Driscoll-Kraay standard error in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 10: Yield Regression

	T = 1		T = 2		T = 3		T = 5	
	(28)	(29)	(28)	(29)	(28)	(29)	(28)	(29)
Pre-2014								
$\Delta \log nq_t^{i,qtr}$	0.0002	0.0004	-0.0003	-0.0001	-0.0005	-0.0003	-0.0007	-0.0006
	(0.56)	(1.24)	(-0.69)	(-0.21)	(-1.17)	(-0.87)	(-1.50)	(-1.34)
$\Delta R_t^{i,qtr}$		-0.0052		-0.0053*		-0.0044*		-0.0030
		(-1.87)		(-2.26)		(-2.19)		(-1.60)
N	247	247	247	247	247	247	247	247
Adj. R^2	0.0009	0.0408	0.0025	0.0639	0.0090	0.0573	0.0119	0.0271
Post-2014								
$\Delta \log nq_t^{i,qtr}$	-0.0001	-0.0001	0.0003	0.0003	0.0001	0.0001	-0.0000	-0.0000
	(-0.13)	(-0.15)	(0.80)	(0.80)	(0.33)	(0.32)	(-0.09)	(-0.09)
$\Delta R_t^{i,qtr}$		0.0023		0.0019		0.0012		-0.0005
		(0.99)		(0.91)		(0.67)		(-0.25)
N	72	72	72	72	72	72	72	72
Adj. R^2	0.0002	0.0140	0.0074	0.0207	0.0016	0.0082	0.0001	0.0010

Notes: Data from Q4 2004. Panel Regression with Fixed Effect. t statistics using Driscoll-Kraay standard error in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 9, Table 10, and Table 11 are analogs of Table 4, Table 5, and Table 6 in the main paper, respectively. The notional issuance has no significant effect on dividend yields and dividend prices. Nevertheless, the issuance affects the dividend yield term structure. The higher dividend supply leads to more inverted 2y1y, 3y1y, 3y2y, 5y1y dividend yield term

Table 11: Yield Term Structure Regression

	$T_1,T_2=1,2$		$T_1,T_2=1,3$		$T_1,T_2=2,3$		$T_1,T_2=1,5$		$T_1,T_2=2,5$		$T_1,T_2=3,5$	
	(30)	(31)	(30)	(31)	(30)	(31)	(30)	(31)	(30)	(31)	(30)	(31)
Pre-2014												
$\Delta \log nq_t^{i,qtr}$	-0.0005*	-0.0005*	-0.0007*	-0.0008*	-0.0002	-0.0003*	-0.0009*	-0.0010*	-0.0004	-0.0004	-0.0002	-0.0002
	(-2.58)	(-2.32)	(-2.55)	(-2.41)	(-2.06)	(-2.24)	(-2.27)	(-2.12)	(-1.68)	(-1.71)	(-1.28)	(-1.24)
[1em] $\Delta R_t^{i,qtr}$		-0.0001		0.0008		0.0009		0.0013		0.0013		0.0005
		(-0.09)		(0.62)		(1.57)		(0.68)		(1.18)		(0.66)
N	247	247	247	247	247	247	247	247	247	247	247	247
Adj. R^2	0.0219	0.0219	0.0251	0.0274	0.0142	0.0305	0.0233	0.0266	0.0127	0.0231	0.0065	0.0096
Post-2014												
$\Delta \log nq_t^{i,qtr}$	0.0004	0.0004	0.0002	0.0002	-0.0002**	-0.0002**	0.0000	0.0000	-0.0004*	-0.0004**	-0.0002	-0.0002
	(1.63)	(1.66)	(0.74)	(0.79)	(-3.43)	(-3.58)	(0.09)	(0.14)	(-2.82)	(-3.31)	(-1.74)	(-1.97)
$\Delta R_t^{i,qtr}$		-0.0004		-0.0011		-0.0007		-0.0028		-0.0024*		-0.0017*
		(-0.74)		(-1.32)		(-1.66)		(-2.21)		(-2.88)		(-3.08)
N	72	72	72	72	72	72	72	72	72	72	72	72
Adj. R^2	0.0494	0.0522	0.0011	0.0181	0.0253	0.0429	0.0001	0.0305	0.0182	0.0590	0.0094	0.0563

Notes: Data from Q4 2004. Panel Regression with Fixed Effect. t statistics using Driscoll-Kraay standard error in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

structure in the pre-2014 sample and more inverted 3y2y and 5y2y dividend yield term structure in the post-2014 sample.

I Time-Series Regression Results of the Effect of Structured Products on T-Maturity Asset Prices

This section shows the individual time series regression for each equity index. Table 12 is an analog of Table 4 in the main paper.

Table 12 shows time series regression results for each underlying index. Similar to the pooled panel, the coefficient in front of the log difference of notional issuance is mostly insignificantly negative. The exceptions include NKY and UKX.

For NKY, a percentage increase in the normalized notional issuance prominently decreases the price of 5-year dividends. The statistical significance is lost once we control for the percentage change in spot levels. This implies that the notional issuance is negatively correlated with spot levels. There are many possible explanations. Investors might have less appetite for structured products when the index level is high. Index volatility may be low when spots are high, making structured products less attractive, etc.

A percentage increase in the normalized notional issuance decreases the price of 2-, 3-, and 5-year UKX dividends. After controlling for the change in spots, the impact remains significant only for 5-year prices.

Table 12: Price Regression

	T = 1		T = 2		T = 3		T = 5	
	(26)	(27)	(26)	(27)	(26)	(27)	(26)	(27)
SPX (Q4 2004 - Q4 2016)								
$\Delta \log nq_t^{i,qtr}$	- 0.0545	0.158	-0.747	-0.102	-1.343	-0.262	-2.594	-0.537
	(-0.23)	(0.49)	(-1.12)	(-0.17)	(-1.16)	(-0.29)	(-1.15)	(-0.33)
$\Delta \log S_t^{i,qtr}$		7.411*		22.52***		37.73***		71.80***
		(2.15)		(5.42)		(7.96)		(12.39)
N	49	49	49	49	49	49	49	49
SX5E (Q4 2004 - Q4 2016)								
$\Delta \log nq_t^{i,qtr}$	0.0821	1.076	-3.603	-0.0555	-7.157	-0.836	-13.87	-1.943
	(0.04)	(0.78)	(-0.57)	(-0.02)	(-0.66)	(-0.23)	(-0.70)	(-0.30)
$\Delta \log S_t^{i,qtr}$		34.29**		122.3***		218.0***		411.3***
		(2.84)		(5.41)		(6.17)		(8.07)
N	49	49	49	49	49	49	49	49
NKY (Q4 2004 - Q4 2016)								
$\Delta \log nq_t^{i,qtr}$	-1.729	0.647	-13.45	-3.518	-30.38	-10.54	-73.22*	-33.18
	(-0.34)	(0.13)	(-1.24)	(-0.36)	(-1.61)	(-0.71)	(-2.11)	(-1.34)
$\Delta \log S_t^{i,qtr}$		36.27		151.6*		303.0**		611.5***
		(1.05)		(2.22)		(3.09)		(4.21)
N	49	49	49	49	49	49	49	49
UKX (Q2 2006 - Q4 2016)								
$\Delta \log nq_t^{i,qtr}$	-9.997	-4.289	-33.82*	-15.54	-63.70***	-26.82	-97.56***	-27.74*
	(-1.36)	(-0.56)	(-2.18)	(-0.91)	(-4.37)	(-1.72)	(-4.75)	(-2.16)
$\Delta \log S_t^{i,qtr}$		59.20***		189.6**		382.4***		724.0***
		(4.64)		(3.40)		(5.28)		(24.49)
N	43	43	43	43	43	43	43	43
KOSPI2 (Q4 2004 - Q4 2016)								
$\Delta \log nq_t^{i,qtr}$	-0.426	-0.189	-0.635	-0.173	-1.046	-0.351	-1.994	-1.075
	(-1.62)	(-1.01)	(-1.38)	(-0.55)	(-1.59)	(-0.74)	(-1.68)	(-1.20)
$\Delta \log S_t^{i,qtr}$		4.929**		9.607***		14.45***		19.10***
		(3.48)		(4.23)		(4.48)		(3.57)
N	49	49	49	49	49	49	49	49
HSI (Q3 2005 - Q4 2016)								
$\Delta \log nq_t^{i,qtr}$	-82.87	-51.83	-187.8	-106.4	-292.8	-150.1	-527.3	-250.9
	(-1.13)	(-1.17)	(-1.22)	(-1.35)	(-1.20)	(-1.33)	(-1.21)	(-1.33)
$\Delta \log S_t^{i,qtr}$		444.0*		1164.1***		2041.1***		3954.1***
		(2.31)		(3.68)		(4.89)		(6.23)
N	46	46	46	46	46	46	46	46
HSCEI (Q3 2005 - Q4 2013)								
$\Delta \log nq_t^{i,qtr}$	-0.256	1.870	-11.53	-4.92	-24.82	-12.68	-49.85	-25.84
	(-0.05)	(0.68)	(-0.80)	(-0.60)	(-0.93)	(-0.79)	(-1.06)	(-0.82)
$\Delta \log S_t^{i,qtr}$		39.89*		123.9*		227.7**		450.4**
		(2.35)		(2.54)		(2.84)		(3.63)
N	34	34	34	34	34	34	34	34

Notes: t statistics using Newey-West standard error in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Next, we explore the effect of structured product issuance on dividend yields within each equity index. Table 13 displays the individual time-series results from regression equations (28) and (29).

From Table 13, the impact of structured products on dividend yields are muted. A percentage increase in the notional issue only significantly decreases 5-year UKX yields.

We fail to detect the impact of structured product issuance on dividend yields. This might be due to possible omitted variable biases. We try to filter out all common factors affecting dividend yields across the curve by looking at the effect of structured products on the shape of dividend term structure.

Looking at time series regression for each individual index, we lose some predictive power, as evident in Table 14. The coefficient in front of the log difference in dividend supply is mostly negative but insignificantly so. The loss in statistical significance may be due to small sample size for each individual underlying.

A percentage increase in the structured product issuance makes the 2y1y and 3y1y UKX dividend yield term structure and the 2y1y NKY dividend term structure more inverted.

References

David Backus, Nina Boyarchenko, and Mikhail Chernov. Term structures of asset prices and returns. *Journal of Financial Economics*, 2018.

Ravi Bansal and Amir Yaron. Risks for the long run: A potential resolution of asset pricing puzzles. *The journal of Finance*, 59(4):1481–1509, 2004.

Ravi Bansal, Shane Miller, and Amir Yaron. Is the term structure of equity risk premia upward sloping. Technical report, Working Paper, 2017.

Frederico Belo, Pierre Collin-Dufresne, and Robert S Goldstein. Dividend dynamics and the term structure of dividend strips. *The Journal of Finance*, 70(3):1115–1160, 2015.

Oliver Boguth, Murray Carlson, Adlai J Fisher, and Mikhail Simutin. Leverage and the limits of arbitrage pricing: Implications for dividend strips and the term structure of equity risk premia. 2012.

John Y Campbell and John H Cochrane. By force of habit: A consumption-based explanation of aggregate stock market behavior. *Journal of political Economy*, 107(2):205–251, 1999.

Table 13: Yield Regression

	T = 1		T = 2		T = 3		T = 5	
	(28)	(29)	(28)	(29)	(28)	(29)	(28)	(29)
SPX (Q4 2004 - Q4 2016)								
$\Delta \log nq_t^{i,qtr}$	0.0006	0.0006	0.00020	0.0002	0.0001	0.0001	0.0000	0.0000
	(0.99)	(1.09)	(0.51)	(0.51)	(0.28)	(0.28)	(0.03)	(0.03)
$\Delta R_t^{i,qtr}$		-0.0057		-0.0023		-0.0009		0.0001
		(-1.88)		(-1.44)		(-0.76)		(0.09)
N	49	49	49	49	49	49	49	49
SX5E (Q4 2004 - Q4 2016)								
$\Delta \log nq_t^{i,qtr}$	0.0011	0.0011	0.0001	0.0002	-0.0002	-0.0001	-0.0005	-0.0004
	(0.86)	(0.78)	(0.21)	(0.25)	(-0.38)	(-0.26)	(-1.02)	(-1.04)
$\Delta R_t^{i,qtr}$		0.0056		-0.0016		-0.0046		-0.0072*
		(1.11)		(-0.50)		(-1.52)		(-2.37)
N	49	49	49	49	49	49	49	49
NKY (Q4 2004 - Q4 2016)								
$\Delta \log nq_t^{i,qtr}$	0.0004	0.0006	0.0000	0.0002	-0.0003	-0.0001	-0.0006	-0.0003
	(0.59)	(0.72)	(0.00)	(0.27)	(-0.44)	(-0.10)	(-0.92)	(-0.49)
$\Delta R_t^{i,qtr}$		-0.0031		-0.0043		-0.0054		-0.0068
		(-1.39)		(-1.32)		(-1.35)		(-1.54)
N	49	49	49	49	49	49	49	49
UKX (Q2 2006 - Q4 2016)								
$\Delta \log nq_t^{i,qtr}$	0.0008	0.0007	-0.0006	-0.0006	-0.0013	-0.0013	-0.0009*	-0.0009*
	(0.57)	(0.57)	(-0.42)	(-0.44)	(-1.56)	(-1.54)	(-2.15)	(-2.06)
$\Delta R_t^{i,qtr}$		0.0094*		0.0049		-0.0011		-0.0029
		(2.12)		(1.31)		(-0.51)		(-1.00)
N	43	43	43	43	43	43	43	43
KOSPI2 (Q4 2004 - Q4 2016)								
$\Delta \log nq_t^{i,qtr}$	-0.0008	-0.0005	-0.0005	-0.0003	-0.0007	-0.0005	-0.0011	-0.0010
	(-0.86)	(-0.55)	(-0.73)	(-0.35)	(-1.08)	(-0.82)	(-1.29)	(-1.22)
$\Delta R_t^{i,qtr}$		-0.0082		-0.0095		-0.0071		-0.0041
		(-1.48)		(-1.74)		(-1.41)		(-1.03)
N	49	49	49	49	49	49	49	49
HSI (Q3 2005 - Q4 2016)								
$\Delta \log nq_t^{i,qtr}$	-0.0006	-0.0006	-0.0009	-0.0009	-0.0009	-0.0009	-0.0010	-0.0010
	(-0.58)	(-0.58)	(-0.88)	(-0.88)	(-0.87)	(-0.87)	(-0.89)	(-0.88)
$\Delta R_t^{i,qtr}$		-0.0004		0.0003		0.0006		0.0009
		(-0.20)		(0.18)		(0.47)		(0.70)
N	46	46	46	46	46	46	46	46
HSCEI (Q3 2005 - Q4 2013)								
$\Delta \log nq_t^{i,qtr}$	0.0009	0.0009	0.0004	0.0004	0.0002	0.0002	0.0000	0.000
	(1.01)	(0.92)	(0.47)	(0.46)	(0.20)	(0.24)	(0.03)	(0.14)
$\Delta R_t^{i,qtr}$		0.0013		-0.0009		-0.0022		-0.0058
		(0.37)		(-0.23)		(-0.55)		(-1.40)
N	34	34	34	34	34	34	34	34

Notes: t statistics using Newey-West standard error in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 14: Yield Term Structure Regression

| | $T_1, T_2 = 1,2$ | | $T_1, T_2 = 1,3$ | | $T_1, T_2 = 2,3$ | | $T_1, T_2 = 1,5$ | | $T_1, T_2 = 2,5$ | | $T_1, T_2 = 3,5$ | |
	(30)	(31)	(30)	(31)	(30)	(31)	(30)	(31)	(30)	(31)	(30)	(31)
SPX												
$\Delta \log nq_t^{i,qtr}$	-0.0004	-0.0004	-0.0005	-0.0005	-0.0001	-0.0001	-0.0006	-0.000549	-0.0002	-0.0002	-0.0001	-0.0001
	(-1.42)	(-1.69)	(-1.30)	(-1.55)	(-0.95)	(-1.10)	(-1.27)	(-1.49)	(-1.03)	(-1.17)	(-1.04)	(-1.12)
$\Delta R_t^{i,qtr}$		0.0034		0.0048		0.0014		0.0058		0.0025		0.0011
		(1.85)		(1.76)		(1.51)		(1.68)		(1.45)		(1.20)
N	49	49	49	49	49	49	49	49	49	49	49	49
SX5E												
$\Delta \log nq_t^{i,qtr}$	-0.0010	-0.0009	-0.0013	-0.0012	-0.0003	-0.0003	-0.0017	-0.0015	-0.0007	-0.0006	-0.0003	-0.0003
	(-1.12)	(-1.06)	(-1.11)	(-1.02)	(-0.99)	(-0.86)	(-1.12)	(-1.03)	(-1.08)	(-0.96)	(-1.08)	(-0.97)
$\Delta R_t^{i,qtr}$		-0.0073*		-0.0102*		-0.0030*		-0.0129*		-0.0056*		-0.0026
		(-2.27)		(-2.39)		(-2.37)		(-2.32)		(-2.22)		(-1.69)
N	49	49	49	49	49	49	49	49	49	49	49	49
NKY												
$\Delta \log nq_t^{i,qtr}$	-0.0004	-0.0004	-0.0007	-0.0006	-0.0003	-0.0002	-0.0010	-0.0009	-0.0006	-0.0005	-0.0003	-0.0002
	(-1.60)	(-1.76)	(-1.59)	(-1.73)	(-1.50)	(-1.54)	(-1.77)	(-1.86)	(-1.81)	(-1.79)	(-1.88)	(-1.69)
$\Delta R_t^{i,qtr}$		-0.0012		-0.0023		-0.0011		-0.0037		-0.0026		-0.0014
		(-0.61)		(-0.79)		(-1.09)		(-1.04)		(-1.50)		(-1.81)
N	49	49	49	49	49	49	49	49	49	49	49	49
UKX												
$\Delta \log nq_t^{i,qtr}$	-0.0014**	-0.0014**	-0.0021*	-0.0020**	-0.0007	-0.0007	-0.00168	-0.0016	-0.0003	-0.0002	0.0004	0.0004
	(-2.71)	(-2.97)	(-2.43)	(-2.77)	(-0.88)	(-0.88)	(-1.34)	(-1.38)	(-0.20)	(-0.17)	(0.66)	(0.67)
$\Delta R_t^{i,qtr}$		-0.0046		-0.0105*		-0.0060*		-0.0123*		-0.0078*		-0.0018
		(-1.42)		(-2.16)		(-2.15)		(-2.25)		(-2.25)		(-0.85)
N	43	43	43	43	43	43	43	43	43	43	43	43
KOSPI2												
$\Delta \log nq_t^{i,qtr}$	0.0003	0.0003	0.0000	0.000	-0.000	-0.0003	-0.0003	-0.0004	-0.0006	-0.0007	-0.0003	-0.0004
	(0.52)	(0.56)	(0.06)	(0.00)	(-1.43)	(-1.56)	(-0.48)	(-0.55)	(-1.66)	(-1.58)	(-1.27)	(-1.21)
$\Delta R_t^{i,qtr}$		-0.0013		0.0011		0.0024		0.0041		0.0054*		0.0030
		(-0.82)		(0.53)		(1.75)		(1.27)		(2.08)		(1.65)
N	49	49	49	49	49	49	49	49	49	49	49	49
HSI												
$\Delta \log nq_t^{i,qtr}$	-0.0003	-0.0003	-0.0003	-0.0003	-0.0000	-0.000	-0.0004	-0.0004	-0.0001	-0.0001	-0.0001	-0.0001
	(-1.73)	(-1.79)	(-1.21)	(-1.21)	(-0.10)	(-0.14)	(-0.95)	(-0.94)	(-0.27)	(-0.28)	(-0.35)	(-0.35)
$\Delta R_t^{i,qtr}$		0.0006		0.0010		0.0004		0.0013		0.0007		0.0003
		(0.87)		(0.95)		(0.95)		(0.83)		(0.68)		(0.46)
N	46	46	46	46	46	46	46	46	46	46	46	46
HSCEI												
$\Delta \log nq_t^{i,qtr}$	-0.0005*	-0.0005*	-0.0007	-0.0007	-0.0002	-0.0002	-0.0007	-0.0007	-0.0002	-0.0002	0.0000	0.0000
	(-2.04)	(-2.30)	(-1.80)	(-1.99)	(-1.38)	(-1.46)	(-1.52)	(-1.57)	(-0.88)	(-0.77)	(0.17)	(0.28)
$\Delta R_t^{i,qtr}$		-0.0022**		-0.0035**		-0.0013***		-0.0041***		-0.0019*		-0.0006
		(-2.79)		(-3.54)		(-4.92)		(-4.39)		(-2.55)		(-0.82)
N	34	34	34	34	34	34	34	34	34	34	34	34

Notes: t statistics using Newey-West standard error in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Xavier Gabaix. Variable rare disasters: An exactly solved framework for ten puzzles in macro-finance. *The Quarterly journal of economics*, 127(2):645–700, 2012.

Nicolae Garleanu, Lasse Heje Pedersen, and Allen M Poteshman. Demand-based option pricing. *The Review of Financial Studies*, 22(10):4259–4299, 2009.

Stefano Giglio, Matteo Maggiori, and Johannes Stroebel. Very long-run discount rates. *The Quarterly Journal of Economics*, 130(1):1–53, 2014.

Stefano Giglio, Matteo Maggiori, Johannes Stroebel, and Andreas Weber. Climate change and long-run discount rates: Evidence from real estate. Technical report, National Bureau of Economic Research, 2015.

Niels Joachim Gormsen. Time variation of the equity term structure. 2017.

Robin Greenwood and Dimitri Vayanos. Bond supply and excess bond returns. *The Review of Financial Studies*, 27(3):663–713, 2014.

Martin Lettau and Jessica A Wachter. The term structures of equity and interest rates. *Journal of Financial Economics*, 101(1):90–113, 2011.

Hanno Lustig, Andreas Stathopoulos, and Adrien Verdelhan. The term structure of currency carry trade risk premia. 2014.

Jules Van Binsbergen, Michael Brandt, and Ralph Koijen. On the timing and pricing of dividends. *The American Economic Review*, 102(4):1596–1618, 2012.

Jules Van Binsbergen, Wouter Hueskes, Ralph Koijen, and Evert Vrugt. Equity yields. *Journal of Financial Economics*, 110(3):503–519, 2013.

Jules H Van Binsbergen and Ralph SJ Koijen. The term structure of returns: Facts and theory. *Journal of Financial Economics*, 124(1):1–21, 2017.

Dimitri Vayanos and Jean-Luc Vila. A preferred-habitat model of the term structure of interest rates. Technical report, National Bureau of Economic Research, 2009.