1. An Overview of Financial System and Financial Theory

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1 Introduction

This session provides a very brief overview of the financial system and financial theory. Our aim is to highlight some key ideas and, more importantly, provide references to the literature that will enable the students to develop a good understanding of the financial models that can be used to understand how assets with risky pay-offs may be valued. Our list of references, of course, is far from exhaustive.

2 Intended Learning Outcomes

By the end of this session, students should be able to recognise the literature on

1. the significance of financial markets in the economy;
2. the nature of uncertainty and risk; and
3. models that seek to determine the value of risky assets.

3 Prerequisites

We assume that students have some background in the theory and practice of finance. For example, we assume that students know different securities that companies use to raise capital (e.g. stocks and bonds), and have had some exposure to the portfolio theory (e.g. diversification and risk-return trade-off). We also assume that students have very basic understanding of probability (e.g. know a bit about random variables and their probability distributions) and statistics (e.g. know that data can be used to estimate parameters of probability distributions). We also assume that students remember some of their high-school matrix algebra (e.g. determinant and inverse of a matrix) and calculus (e.g. functions and basic optimisation). Some data sets used in these notes are hypothetical and are created for teaching purposes only. Where real data is used, we do specify sources.

4 Finance and Financial System

4.1 What Does Financial Theory Do?

Financial theory studies the allocation of scarce resources over time. The theory generates models of the behaviour of economic agents (i.e. individuals, firms and governments) who interact by trading a variety of assets, such as stocks and bonds. The trading between economic agents is facilitated by financial markets (e.g. stock markets and over-the-counter markets) and institutions (e.g. banks).

An important element of the financial theory is to capture the uncertainty associated with pay-offs that assets generate. As we will see shortly, the financial theory relies heavily on probability and mathematical statistics to estimate uncertainties associated with pay-offs, and then evalautes the implications of these estimates for the allocation decisions of economic agents.

4.2 Financial System

A **financial system** consists of a variety of institutions (e.g. banks) and markets (e.g. stock markets). A key objective of these markets and institutions is to enable economic agents (e.g. individual investors or firms) to meet their consumption and investment needs. For example, many people invest a portion of their monthly income in the stock market with the hope to have higher consumption in the future; many firms borrow from banks in order to invest in new machines or technology. For example, according to a survey of legal firms by the HSBC, over 65% of legal firms in the UK have or would consider borrowing to invest in technology (e.g. cyber security). A short introductory video of the financial system in the UK, produced by the Bank of England, is available here.

4.3 The Evolution of Financial System

There are various ways to assess the evolution the financial system. One way is to consider the size of different elements of the financial system. For example, we may consider how large stock markets or the banking sector are today compared to their size in the past. Figure 1 provides some indicators of the evolution of stock markets and lending by banks in the OECD countries based on data from the World Bank.

This is not an exhaustive list of indicators but they do provide some indication of the importance of financial

markets and institutions. For more on the relationship between financial systems and economic growth, see Levine (1999). Figure 1 also shows CO2 emission from the OECD countries. The role of financial markets in determining changes in the environment is recognised in the literature (Stern, 2008). This important debate, however, is beyond the scope of our sessions. But it is important to note that some of the basic tools that we will study forms the foundation of the debate on the role of finance in protecting the environment.

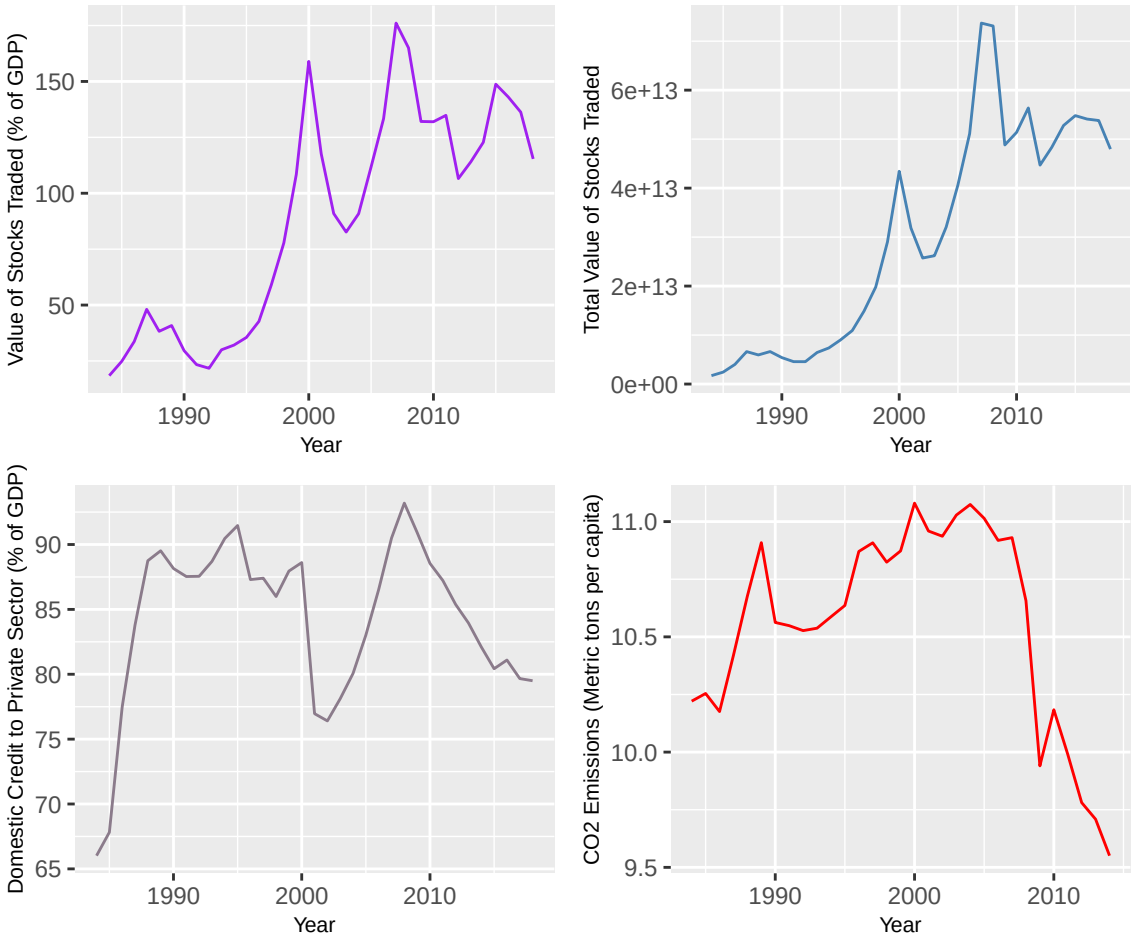

Figure 1: Some Indicators for the OECD Countries

4.4 A Variety of Financial Assets

The variety of financial assets available to economic agents has increased substantially during the last two centuries. Tufano (2003) provides an excellent review of the product and process innovations in the financial sector. Perhaps the key motivations behind these innovations have been the changes in investors' demand to smooth their consumption and the changes in firms' needs to finance their investments in a rapidly evolving environment. Not all innovations benefit investors and firms. Lerner (2010) evaluates the litigation of patents

and concludes that patents linked to financial products and services are more likely to be litigated compared to those granted to non-financial entities.

Two most widely known financial assets are common stocks and bonds. Common stocks are securities issued by public listed companies. Stocks offer investors a share of ownership of the issuing company. Investors buy shares with the hope to receive a portion of future cash flow generated by the issuing company in the form of dividends or capital gains. Most common stock holders also receive a right to vote to determine policies pursued by their firms. Common stocks have limited liability. Bonds are fixed-income securities issued by companies and governments to borrow money from investors. Some bonds pay regular income in the form of coupons. Bonds have a maturity date by which the borrower is expected to pay-off the loan. A key objective of the **financial theory** is to develop models that provide *tentative* understanding of how values of assets such as stocks and bonds are determined.

5 Models in Financial Theory

5.1 Models of Choice in Financial Theory

Financial assets are traded by economics agents interacting in a complex socio-economic environment. In order to understand these interactions and their impacts on the value of risky assets, the financial theory formulates a variety of mathematical models that capture the demand and supply of assets. A majority of these models builds upon the **rational choice theory** and view investors as rational agents who choose an optimal portfolio of risky assets in order to maximise their expected utility (Danthine and Donaldson, 2014). In many models, the prices of assets then emerge through an interaction of utility maximising agents.

More recent advances in the financial theory incorporate insights from psychology and neuroscience, and recognise that people exhibit choice behaviours that may not be consistent with the maximisation of expected utility. For example, recent literature recognises that, instead of carefully analysing a set of alternatives, people tend to use *heuristics* or *rules of thumb* to make choices. For a review of the 'behavioural finance' literature, see Subrahmanyam (2008).

The corporate finance literature that focuses on choices made by different players in the financial system - such as shareholders, debt holders, managers and institutional investors - relies heavily on the **game theoretic reasoning** that enables us to model strategic interactions between these players. For example,

the *principal-agent model* is widely used to evaluate the consequences of possible conflict of interests between shareholders and managers, which, in turn, determines how firms raise capital and the price at which firms can issue their securities. For an excellent introduction to game theory, see Tadelis (2013).

5.2 Uncertainty and Risk

Financial assets vary substantially in terms of their characteristics. For example, stocks vary in terms of whether they allow investors to vote . Bonds vary in terms of their maturity and coupon rates. However, all financial assets have one thing in common: they all offer uncertain pay-off to investors. For example, if you purchase one share of Apple Inc. today for $245 per share, then you do not know the price at which you will be able to sell this asset. Even short-term fixed-income securities such as treasury bills issued by the US government do not offer pay-offs that are completely certain.

Within this context, one of the most important element of financial theory is to understand how value of assets are determined given the uncertainty associated with their pay-offs. Financial theory then needs a language that enables us to describe and quantify uncertainty associated with pay-offs associated with different assets. The financial theory by and large builds upon the axiomatic **probability theory** as a 'mathematical language for quantifying uncertainty' (Wasserman, 2013, p.3). We will provide a very brief overview of a few key concepts of the probability theory. However, it is it is important to note that there is huge literature on the way we **reason about uncertainty**. For an excellent review of this literature, see Halpern (2017).

As we will see, pay-off associated with assets are considered as random variables that follow a particular probability distribution (e.g. normal distribution). Data and techniques (and algorithms) from **mathematical statistics** (and more recently from machine learning) are then used to estimate the parameters of these distributions. We will learn basics of mathematical statistics used in the financial literature in the following sessions. An excellent and concise summary of probability and statistics, see Wasserman (2013).

5.3 Applications of Financial Models

Models that originate from the literature on finance are widely used in the financial sector. Perhaps most well-known examples are models that enable us to value derivative securities (e.g. Black-Scholes Option Pricing Model) or value-at-risk. Indeed, some argue that the incorrect use of financial models was a key

factors that led to the 2007-08 financial crisis. For application of finance using a variety of models and data, see Ruppert and Matteson (2015). This, in our opinion, is one of the best resources to learn essential skills for financial modelling.

6 Next Step

After this brief overview of some key ideas pertaining to the financial theory, the next 3 sessions will provide an introduction to the free statistical software `R`. We will then use `R` to analyse financial data.

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