Master Degree in Economics and Finance

Modeling IPP Capital and its Effect on the Labor Share

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ABSTRACT IN ENGLISH:

We investigate the effects of intellectual property products capital in the evolution of the labor share for five European countries. Using post-revision national accounts data, we construct a benchmark labor share with the contribution of both traditional and IPP capital, against which we measure a counterfactual LS which isolates the effects of IPP. We report that the labor share in Austria, France, Germany, and Spain has been consistently declining, with high variation across countries. Our results show that part of this decline is explained by the inclusion and growing importance of IPP capital in the economy. A closer look at France reveals that the main channels through which IPP has an impact on the labor share are a higher depreciation rate and investment flow relative to traditional capital.

ABSTRACT IN CATALAN:

Investiguem els efectes del capital de productes de propietat intel·lectual en l'evolució de la quota laboral de cinc països europeus. Utilitzant dades de comptes nacionals posteriors a la revisió, construïm una quota de treball de referència amb la contribució del capital tradicional i IPP, enfront del qual es mesura un LS contrafactual que aïllarà els efectes de l'IPP. Informem que la participació laboral a Àustria, França, Alemanya i Espanya ha anat disminuint constantment, amb una alta variació entre països. Els nostres resultats mostren que part d'aquest descens s'explica per la inclusió i la importància creixent del capital de l'IPP en l'economia. Una visió més detallada de França revela que els principals canals pels quals l'IPP té un impacte en la participació laboral són una major taxa d'amortització i un flux d'inversió relatiu al capital tradicional.
MASTER PROJECT

Modeling IPP Capital and its Effect on the Labor Share

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Abstract

We investigate the effects of intellectual property products capital in the evolution of the labor share for five European countries. Using post-revision national accounts data, we construct a benchmark labor share with the contribution of both traditional and IPP capital, against which we measure a counterfactual LS which isolates the effects of IPP. We report that the labor share in Austria, France, Germany, and Spain has been consistently declining, with high variation across countries. Our results show that part of this decline is explained by the inclusion and growing importance of IPP capital in the economy. A closer look at France reveals that the main channels through which IPP has an impact on the labor share are a higher depreciation rate and investment flow relative to traditional capital.
1 Introduction

The labor share (LS) is essential to the way in which we model aggregate macroeconomic phenomena and understanding the changes in its behavior has fundamental implications for inequality, labor markets and capital formation. We study the evolution of the LS in five European countries. Contrary to the traditional notion that the proportion of national income allocated to labor has remained constant, we find it has been declining for four of the five countries in our study. Moreover, by isolating the effects of intellectual property products (IPP) from aggregate capital, we observe that part of the dynamics of the LS of all our sampled countries is explained by the growing importance of intangible capital in the economy.

An empirical puzzle for economists, Keynes (1939) described the stability of the LS as “one of the most surprising, yet well-established, facts in the whole range of economic statistics” (p.45) and later Kaldor (1957) pronounced it one of the stylized facts of economic growth. In this way, the alleged constancy of the LS has become nearly an unquestionable axiom of macroeconomics as long-standing models that are consistent with a trendless LS, like the Cobb-Douglas aggregate production function, have come to dominate the empirical and theoretical field of economic research.

Recent literature has challenged this notion. Growing evidence suggests that the LS has been, in fact, declining (Elsby et al. (2013), Karabarbounis and Neiman (2014), Piketty and Zucman (2014), Koh et al. (2016), Autor et al. (2017)). Similarly, using pre-revision data, the OECD (2012) Employment Outlook shows that the labor share has declined significantly between 1990 and 2009 in 26 out of 30 advanced economies. While there is consensus that the LS has been falling, at least since the 1980s, there is still controversy over the causes behind the decline and the extent up to which it is a measurement issue.

In particular, Koh et al. (2016) show that the increasing importance of IPP capital in the US economy entirely accounts for the observed decline in the LS between 1947 and 2013. Using post-revision BEA data, they argue that the capitalization of IPP (specifically, the incorporation of Software investment in 1999 and R&D and artistic originals in 2013) and an increase in IPP capital income over time completely explain the negative trend of the LS. Evidence on whether this is a global phenomenon or only restricted to the US economy remains limited.

We look at the LS and the capital composition of five European countries to understand the degree up to which the growing importance of IPP capital in the national accounts explains the LS trend. European national accounts underwent a revision in 2013
(ESA 2010) that begun including investment in IPP products (in particular, software investment, R&D and artistic originals) as aggregate capital. Using revised data, our results show that the LS in Austria, France, Germany, and Spain has been consistently declining at varying degrees, from -12.69% in Spain to -5.88% in Germany. Most importantly, we find that IPP capital accounts for part of this observed decline in all the countries sampled.

A more detailed study for the case of France reveals the fundamental differences between traditional and intangible capital, mostly arising from the higher levels of depreciation and investment flow that the latter exhibits. In this way, the secular decline of the LS is partially due to a measurement issue and reflects the different ways in which we have begun to think about what is capital.

The paper is organized as follows: we begin by presenting the data and the methodology in section 2. From here we construct a benchmark LS, from aggregate capital, and a counterfactual LS that isolates the effects of IPP capital in the economy. In section 3, we report our results and show that the dynamics of the LS in our sample of European countries is partially explained by the inclusion of IPP capital. We proceed by analyzing in depth the case of France in which we look at the three potential channels through which IPP capital affects the LS: the depreciation rate, the investment flow and the price of investment. Finally, we conclude in section 4.

2 Methodology and Data

2.1 Data

All data series are retrieved from Eurostat and EU KLEMS. We use data from Eurostat and follow the income approach in which GDP is the sum of income generated in the economy (compensation of employees, taxes on production and imports less subsidies, gross operating surplus and mixed income of the total economy). Data on depreciation rates, the capital stock, gross fixed capital formation and the price index of fixed capital formation is obtained from the 2016 EU KLEMS release Jäger (2016). Detailed information on the data sources for both Eurostat and EU KLEMS is provided in Appendix A.1.

We focus our analysis on the following countries:

Austria - AT (1995-2014);
France - FR (1978-2014);
Germany (2000-2014);
Italy - IT (1995-2013);

As a consequence of the ESA 2010 revision, the availability of historic data is limited. This is a central limitation for our analysis. France constitutes an exception as it provides revised historic data beginning in 1978. Using pre-revision data (ESA 95) would be incompatible with our exercise, since it does not treat R&D investment as value added. Therefore, we need to rely solely on the post-revision data despite its constrained time series availability.

2.2 The aggregate LS

In this section we obtain an aggregate LS, which we use as a benchmark LS. We follow Koh et al. (2016) and use the standard definition of the LS as described in Cooley and Prescott (1995). While there is a proportion of income that is attributed unambiguously to labor and to capital, there is a fraction, which is ambiguous in its allocation. Following the standard definition, we compute the share of capital income to unambiguous income and assign this same share to capital income from ambiguous income. Specifically, we calculate the following components to obtain the benchmark LS:

1. Unambiguous Capital Income (UCI) = Gross Operating Surplus + Net Property Income

2. Unambiguous Income (UI) = UCI + Depreciation (DEP) + Compensation of Employees (CE)

3. Ratio of Unambiguous Capital Income to Unambiguous Income:

\[ \alpha = \frac{UCI + DEP}{UI} \]

4. Ambiguous Income = Gross Mixed Income (GMI) + Taxes on Production and Imports - Subsidies

5. Ambiguous Capital Income = \( \alpha \cdot AI \)

6. Capital Income (CI) = UCI + DEP + AI

7. Labor Share = \( LS_B = 1 - \text{Capital Share} = 1 - \frac{\text{Capital Income}}{Y} \),
where \( Y = \text{Gross National Product (GNP)} = UCI + DEP + CE + AI. \)
All data other than that for the stock of depreciation is retrieved from Eurostat ESA 2010 national accounts data. For the stock of depreciated capital, we compute the values from the depreciation rates and capital stock (see Appendix A.2).

2.3 The counterfactual LS

In this section we build a counterfactual LS that only takes into account the contribution of traditional capital to national income and compare it with our benchmark LS:

\[ LS_T = 1 - \frac{R_T k_T^x}{y - R_{IPP} k_{IPP}^x} \]  

(1)

where \( LS_T \) is the traditional LS computed using only capital income from traditional capital, \( y \) is the gross national product (GNP), \( k_T^x \) is the capital stock in efficiency units, and \( R_i \) is the gross return to capital, for \( i \in \{ T, IPP \} \).

Eurostat and EU KLEMS do not directly provide information on the gross return to investment \( R \). We therefore recover a time series for the rates of return \( R_{IPP} \) and \( R_T \) using a standard investment model with two types of capital, traditional and IPP.

In particular, we consider a generic competitive framework with only one final consumption good and a generic aggregate production function with constant returns to scale (CRS) and two capital inputs, traditional and IPP. It is worth to stress that we are not imposing any functional form on the production function other than CRS.

The optimal conditions for the profit maximization of the firm implies that the gross return to capital, or the marginal product of capital, for each of the two types of capital is given by:

\[ R_{i,t+1} = p_{i,t}(1 + r_{t+1}) - p_{i,t+1}(1 - \delta_{i,t+1}) \], \quad \text{with } i \in \{ T, IPP \}  

(2)

where the time series for the depreciation rate \( \delta_{i,t} \) and the price of investment \( p_{i,t} \), both for IPP and traditional capital, are directly retrievable from EU KLEMS, as described in the appendix A. Thus, the only unknown in the previous expression is \( r \), the net return of investment, that is assumed to be constant across the two sectors, following Cooley and Prescott (1995).

We pin down \( r \) by matching the benchmark \( LS_B \) (left hand side), calculated as explained in section 2.2, with the model LS (right hand side):
\[
LS_B = 1 - \frac{R_T(r, p_T, \delta_T) \cdot k_T + R_{IPP}(r, p_{IPP}, \delta_{IPP}) \cdot k_{IPP}}{y}
\]  

where the net interest rate \( r \) is the only unknown of the equation, which can be easily determined (see Appendix A.6). From here, we plug \( r \) back to equation 2, and find the gross return to investment for IPP and traditional capital. We finally compute the counterfactual LS from equation 1.

3 Results

We structure the presentation of our results in three sections. First, we document the evolution of both the aggregate and the counterfactual LS for all of our sample countries (3.1). We then put our results in context with the findings by Koh et al. (2016) (3.2). Due to better data availability for France, we carry out a more detailed analysis in which we look at the three channels through which IPP capital affects the LS (3.3).

3.1 Benchmark and Counterfactual LS for Sample Countries

For all of our sample countries, with the exception of Italy, the aggregate LS has been declining. A cross-country comparison shows that the LS dynamics vary substantially in the sampled countries. From Table 1 we observe that the share of national income that goes to labor in Spain has been declining during the surveyed period by 12.69%, in France by 11.72%, in Austria by 9.47% and in Germany by 5.88%. We observe a trendless LS for Italy with a marginal increase over time of 0.75%.

Similarly, we find variation in the extent up to which IPP capital can explain the observed path of the LS (see Table 1 and Figure 1). For example, almost a fourth of the decline in the LS in France can be attributed to the effects of IPP and approximately a fifth in Austria. For the case of Germany and Spain, we only observe that 6% and 3% respectively of the decline can be attributed to IPP capital. In the case of Italy, we find a slightly increasing counterfactual LS.

\footnote{We find that for Italy, the slope of the LS increases by 83% as we move from the aggregate to the counterfactual. We refrain from interpreting these numbers since both, the benchmark and the counterfactual LS are nearly flat.}
### Table 1: Percentage change of aggregate and traditional LS trends

<table>
<thead>
<tr>
<th></th>
<th>Austria</th>
<th>France</th>
<th>Germany</th>
<th>Italy</th>
<th>Spain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate</td>
<td>-9.47%</td>
<td>-11.72%</td>
<td>-5.88%</td>
<td>0.75%</td>
<td>-12.69%</td>
</tr>
<tr>
<td>Traditional</td>
<td>-7.44%</td>
<td>-8.64%</td>
<td>-5.33%</td>
<td>1.37%</td>
<td>-11.93%</td>
</tr>
<tr>
<td>Decline explained by IPP Capital</td>
<td>19%</td>
<td>24%</td>
<td>6%</td>
<td>N/A</td>
<td>3%</td>
</tr>
</tbody>
</table>

#### 3.2 Comparison of results with Koh et al. (2016)

For the case of Austria and France, we can confirm that the transition to a more IPP capital-intensive economy has a considerable impact on the trend of the LS.

Koh et al. (2016) find that the inclusion and growing importance of IPP capital in the US can entirely account for the decline of the US LS. Our results allow us to partially compare the case of our countries in Europe to the US. To begin with, we do not recover a trendless counterfactual LS from disaggregating the effects of IPP capital. In other words, IPP capital does seem to explain parts of the dynamic of the LS in our sample of European countries, but it does not entirely do so.

Part of the difference in our findings and those of Koh et al. (2016) comes from the limitations we encounter with the data. Specifically, the European national accounts have revised data that is available at a substantially shorter time horizon than that used by Koh et al. (2016); the US has data with capitalized IPP starting in 1947. In this way, we cannot directly compare the quantitative magnitude of our results with those of Koh et al. (2016).

As we drop the beginning observations for the US time series and thereby shorten the time horizon to a length that is comparable to our European series, we notice that the part of the decline in the US LS explained by IPP also decreases considerably. This stresses the fact that the time horizon is most likely underestimating the level up to which IPP explains the trend of the LS in our results.

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1 When we shorten the US time series to a length comparable to the French one, from 1980-2013, the decline in the LS explained by IPP drops to 69% and when we use US data starting in 1995, it drops to 44%.
3.3 A Closer Look at France: Depreciation Rate, Investment Flows and Price of Investment

France provides all relevant data for our analysis from 1978 up to 2014, which motivates a more detailed look at the relationship between IPP capital and the LS. As we have seen, the aggregate LS in France has been declining since 1978 by 11.7%, and 24% of this decline is explained by the inclusion of IPP capital into the national accounts. During this same period of time, the importance of IPP capital as a share of total capital has gone from 11% in 1978 to 23% in 2014, reflecting the transition France has undergone into a more IPP capital-intensive economy.

We follow Koh et al. (2016) and consider the three potential channels through which IPP capital affects the LS; namely, the depreciation rate, investment flow and price of investment of both IPP and traditional capital. In order to assess how IPP capital has an impact on the LS in ways that are different from those in which traditional capital affects it, we need to carry out a closer examination of these three particular elements.

With respect to the depreciation, IPP capital exhibits a much higher rate than that of traditional capital. Moreover, the difference between the rates at which IPP and traditional capital deplete has been widening over time. In 1978 the depreciation rate of IPP capital was 6.5 times that of traditional capital and in 2014 IPP capital depreciated 8.8 times faster than traditional capital did (Figure 2d).

In terms of the investment flow, IPP capital has increased by a factor of 12, a stark contrast to the rate of traditional capital, which has increased just by a factor of 5 (Figure 2a). The rapid increase in investment is, on the one hand, driven by the higher rates at which intangible capital products depreciate and, on the other, reflected in the increase in IPP investment as a share of aggregate capital investment in the last years.

Contrary to the investment flow and the depreciation rate, the price of investment for IPP and traditional capital move together (Figure 2c). More concretely, the price does not significantly differ from one type of capital to the other, showing a slight decrease in time for both, IPP and traditional capital.

We can infer from these results that a high investment flow coupled with a high depreciation rate are the main ways in which IPP is affecting aggregate capital and thereby the LS. The price of investment of IPP and traditional capital does not differ substantially between both types of capital. Therefore, we cannot conclude that the
price of investment is an essential channel through which aggregate capital has come to change the dynamics of the factor shares.

4 Conclusion

Our analysis of IPP capital and its impact on the LS reveals three main findings. First, we observe a decline in the LS of Austria, France, Germany and Spain, part of which is explained by the impact of IPP capital on aggregate income. Second, a cross-country comparison discloses great variation in both the magnitude at which the LS is falling in these countries and the extent up to which IPP capital can account for such a decline. Finally, a deeper analysis for France, in which we study the dynamics and composition of its aggregate capital, allows us to identify the higher depreciation rate and investment flow of IPP capital as the main channels driving the change in the trend of the LS.

We conclude that, to an extent, the behavior of the LS attests to the transition into more IPP capital-intensive economies. Since the inclusion of intangible capital in the revised European national accounts (ESA 2010), the growing importance of IPP relative to traditional capital has altered essential properties of aggregate capital, such as the depreciation rate. In particular, these changes have translated into new dynamics and ways in which factors are allocated in the economy.

In using revised data, our analysis presents novel evidence for LS dynamics in Europe and its relation to the composition of capital in the economy. From a measurement point of view, it highlights the way in which we have begun to think differently of developments and aggregate indicators. From a theoretical point of view, it compels us to reformulate models that can accommodate these new measurements and their implications for the rest of the economy.

As a final remark, we have not attempted to establish a connection between the LS and inequality. However, the relation between the compensation to labor and the concentration of IPP capital poses interesting challenges for future research. Particularly relevant to this study are the potential ways in which a decline in the LS propelled by an increase in IPP capital maps onto the evolution of inequality.
5 Figures

Figure 1: Effects of IPP Capital on Labour Share

(a) Austria

(b) Germany
(c) Italy

(d) Spain
(e) France
Figure 2: Traditional Capital vs IPP Capital, France

(a) Traditional Capital and IPP Investment Levels

(b) Traditional Capital and IPP Investment Shares

(c) Relative Price of Traditional Capital and IPP Investment

(d) Depreciation Rate of Traditional Capital and IPP Capital
Appendix A   The Construction of Aggregate Data Series

A.1 The Source of Data

Eurostat
In order to compute the benchmark LS we rely on the income approach in which GDP is the sum of income generated in the economy (compensation of employees, taxes on production and imports less subsidies, gross operating surplus and mixed income of the total economy).

These data can be downloaded from Eurostat/Database by themes/Economy and Finance/ National Accounts/Annual Sector Accounts/Non-Financial transactions (ESA 2010) (nasa_10_nf_tr);

1. Compensation of Employees (D.1) is defined as the total remuneration, in cash or in kind, payable by an employer to an employee in return for work done by the latter during an accounting period.

2. Taxes on Production and Imports (D.2) consist of compulsory, unrequited payments, in cash or in kind, which are levied by general government, or by the institutions of the European Union, in respect of the production and importation of goods and services, the employment of labor, the ownership or use of land, buildings or other assets used in production. Such taxes are payable irrespective of profits made.

3. Subsidies (D.3) are current unrequited payments which general government or the institutions of the European Union make to resident producers.

4. Property Income (D.4) accrues when the owners of financial assets and natural resources put them at the disposal of other institutional units. The income payable for the use of financial assets is called investment income, while that payable for the use of a natural resource is called rent. Property income is the sum of investment income and rent.

5. Gross Operating surplus (B2G) is the surplus (or deficit) on production activities before account has been taken of the interest, rents or charges paid or received for the use of assets.

6. Gross Mixed income (B3G) is the remuneration for the work carried out by the owner (or by members of his family) of an unincorporated enterprise. This is referred to as ‘mixed income’ since it cannot be distinguished from the entrepreneurial profit
of the owner.

Additionally, we recover the price of consumption

\[ P_t^c = \text{Consumption price index (HICP)} \]

**EU KLEMS**

Types of Capital: \( i \in \{ T, IPP \} \).

Traditional and IPP capital are composed by the following types of assets:

**TRADITIONAL** = (1) Transports, (2) Other Machinery Equipment and Weapons, (3) Computer hardware, (4) Telecom. equipment, (5) Cultivated Assets, (6) Dwellings, (7) Other Buildings and Structures; \( j \in \{ 1, \ldots, M \} \), where \( M=7 \)

**IPP** = (1) Computer Software and Databases, (2) Research and Development, (3) Mineral Exploration and Artistic Originals; \( j \in \{ 1, \ldots, N \} \), where \( N=3 \)

Types of Industries \( k \in \{ 1, \ldots, L \} \), where \( L = 34 \) in line with NACE 2 industry classification.

**Variables:** (every yearly observation at the industry level and at the aggregate level)

- \( I = \) Nominal gross fixed capital formation, in millions of national currency;
- \( P = \) Gross fixed capital formation price index (2010=100.0);
- \( K = \) Nominal capital stock, in millions of national currency;
- \( \delta = \) Geometric depreciation rates.

**A.2 Depreciation Stock by Type of Capital**

This analysis applies for any specific country in any particular year. Thus, in this section we avoid to include the time-subscript \( t \).

Since we have depreciation rates at industry level, we first compute the depreciated stock of capital for each type of asset \( J \) for each specific industry \( K \) as:

\[ DEP_{j,k} = \delta_{j,k} \cdot K_{j,k} \]

Next, we aggregate the depreciated stock at the industry level in order to compute the depreciated stock for each different type of capital \( i \), traditional and IPP:
\[ \text{DEP}_i = \sum_{j=1}^{N,M} \sum_{k=1}^{L} \text{DEP}_{j,k} \]

Finally, we can compute the total depreciated stock of capital by summing the IPP and T component:

\[ \text{DEP} = \text{DEP}_T + \text{DEP}_{IPP} \]

Moreover, we can also compute the depreciation rate for IPP and traditional capital as:

\[ \delta_i = \frac{\text{DEP}_i}{K_i} \]

Where \( K_i \) is the sum of the nominal capital stocks of different type of assets for IPP and traditional capital.

**A.3 Investment by Type of Capital**

We construct the nominal investment in traditional and IPP capital, and the associated investment shares, which will be used in the construction of price indices in section A.4. EU KLEMS provide the nominal investment \( I \) (nominal gross fixed capital formation) at the aggregate level for each type of assets. Therefore, the total nominal investment for IPP and traditional capital is easily computed as the sum of different type of assets. Moreover, the investment shares of each type of assets are computed as:

\[ s_j = \frac{I_j}{I_i} \]

**A.4 Relative Price of Investment by Type of Capital**

We construct the relative price of investment in traditional and IPP capital as explained by Koh et al. (2016). In computing the price index of traditional investment, we use a Törnqvist price index.

EU KLEMS provides the gross fixed capital formation price index for each type of assets. Hence, the growth rate of the price index of each type of assets is given by:
\[ \lambda(P^i_t) = \frac{P^i_j}{P^i_{t-1}} - 1 \]

Combining the previous growth rates for each type of assets, we can compute the growth rate of the Törnqvist price index of the traditional and IPP investment as:

\[ \lambda(P^i_t) = \sum_{j=1}^{N,M} \left( \frac{s^j_t + s^j_{t-1}}{2} \right) \cdot \lambda(P^j_t) \]

where \( s^j \) is the investment share for type of assets \( j \) computed in the previous section. Then, the level of the price indices of investment in traditional and IPP capital are recovered recursively as:

\[ P^i_t = (1 + \lambda(P^i_t)) P^i_{t-1} \]

where \( P^i_0 \) is normalized to 1 at the initial period.

Finally, the relative price of investment is normalized using the consumption price index \( P^c_t \) defined as:

\[ p^i_t = \frac{P^i_t}{P^c_t} \]

### A.5 Stock of Capital in Efficiency Units by Type of Capital

Define the investment in efficiency units by the nominal investment deflated by the price of investment for traditional and IPP capital:

\[ x^i_t = \frac{I^i_t}{P^i_t} \]

Then, we can recursively compute the stock of capital in efficiency units by applying the capital accumulation equation:

\[ k^x_{i,t+1} = x^i_t + (1 - \delta_{i,t}) \cdot k^x_{i,t} \]

where we set the initial value of \( k^x_{i,0} \) equal to the total capital in efficiency units \( i \) at
year 0, \( i \in \{T, IPP\} \).

### A.6 Rate of Return to Capital by Type of Capital

Following the strategy explained in section 2, we find the net rate of return combining equations 2 and 3:

\[
\begin{align*}
    r_t &= (1 - LS_t)y_t + \left[ k^t_{IPP} \cdot p_{t}^{IPP} (1 - \delta_{IPP,t}) + k^t_{T} \cdot p_{t}^{T} (1 - \delta_{T,t}) \right] \\
    &= \frac{k^t_{IPP} \cdot p_{t}^{IPP} - 1 + k^t_{T} \cdot p_{t}^{T} - 1}{k^t_{IPP} \cdot p_{t}^{IPP} + k^t_{T} \cdot p_{t}^{T} - 1}
\end{align*}
\]

where \( LS_t \) is our benchmark LS and \( y_t \) is real GNP deflated by the price of consumption \( P^c_t \).

Since we assume that the net rate of return to capital, \( r_t \), is identical across types of capital, we can plug it back to equation 2 and find \( R_{i,t} \), the gross rate of return.
References


