# Declining Capital Formation and the Role of Intangibles
## □ Empirical Studies Using the Industry-level Data—

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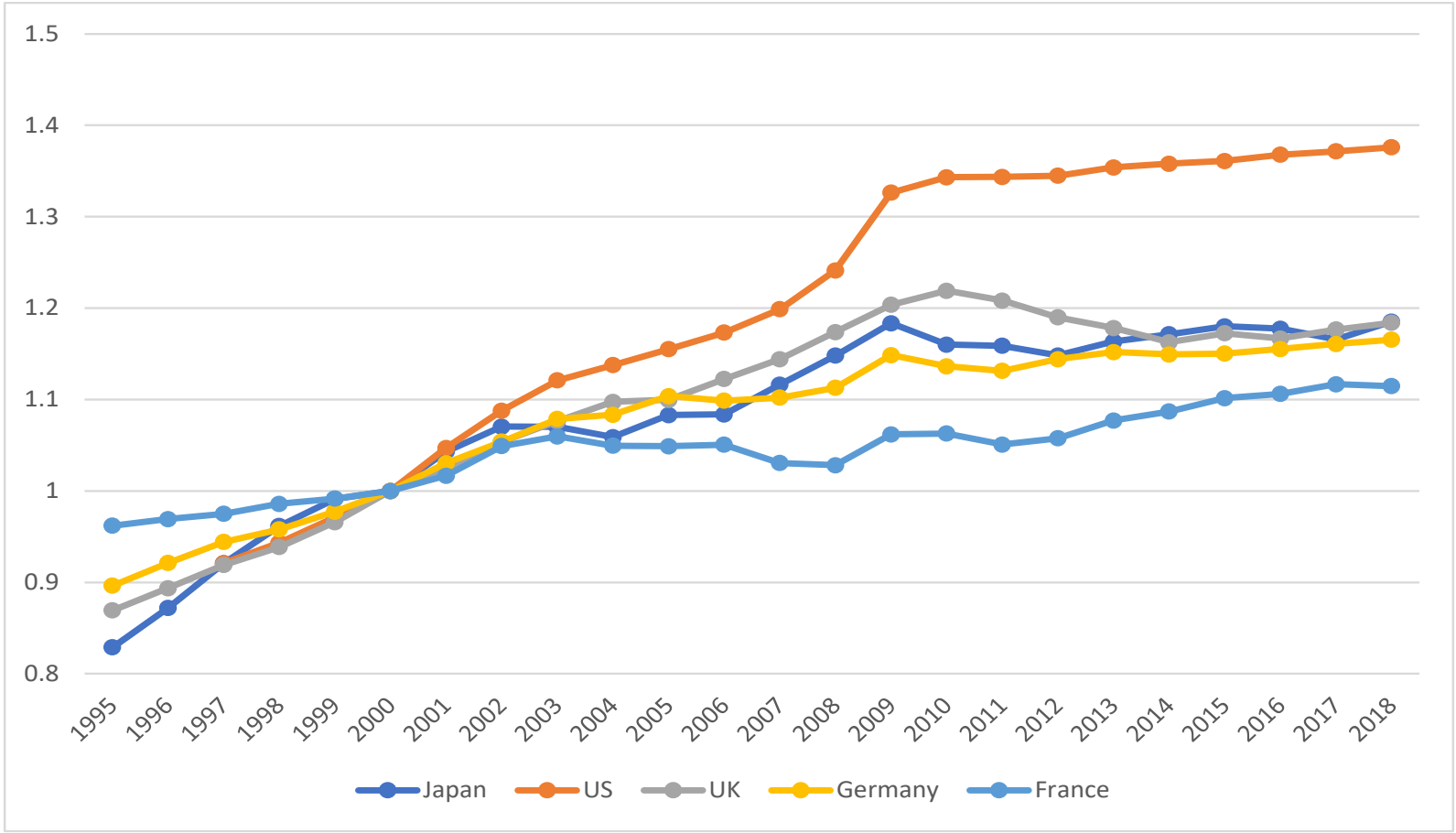
# 1. The Japanese Economy in the 2010s

- **Although the GDP growth rate in the 2010s is higher than in the 2000s, it was still lower than 1%.**
- **The major contributors to the recovery of Japanese economic growth in the 2010s was TFP growth and the increase in labor input.**
- **However, the growth in capital input has stagnated since the 2000s.**
- **Japanese capital accumulation in the 21st century was lower than that in the US that caused secular stagnation in the 2010s.**
- **The aim of our paper: Following Gutierrez and Philippon（2017）and Crouzet and Eberly (2018), we examine how intangible investment relates to the declining capital formation in Japan.**

# Growth Accounting in Japan

| | 1995-2000 | | | 2000-2010 | | | 2010-2018 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Macro economy | Manu-facturing sector | Non-manu-facturing sector | Macro economy | Manu-facturing sector | Non-manu-facturing sector | Macro economy | Manu-facturing sector | Non-manu-facturing sector |
| Real GDP Growth | 1.34% | 1.68% | 1.22% | 0.30% | 0.92% | 0.11% | 0.83% | 1.04% | 0.77% |
| Contribution of Labor Input Growth | 0.03% | -0.99% | 0.35% | -0.14% | -1.17% | 0.15% | 0.18% | -0.01% | 0.23% |
| Contribution of Hours Worked Growth | -0.39% | -1.37% | -0.09% | -0.53% | -1.54% | -0.24% | 0.17% | -0.08% | 0.23% |
| Contribution of Labor Quality Growth | 0.42% | 0.38% | 0.44% | 0.39% | 0.36% | 0.39% | 0.01% | 0.08% | 0.00% |
| Contribution of Capital Input Growth | 0.98% | 0.72% | 1.06% | 0.22% | 0.30% | 0.19% | 0.13% | 0.20% | 0.11% |
| Contribution of Capital Quantity Growth | 0.72% | 0.40% | 0.77% | 0.15% | 0.17% | 0.14% | 0.11% | 0.16% | 0.10% |
| Contribution of Capital Quality Growth | 0.26% | 0.32% | 0.29% | 0.07% | 0.13% | 0.05% | 0.01% | 0.04% | 0.00% |
| TFP Growth | 0.33% | 1.96% | -0.19% | 0.23% | 1.80% | -0.23% | 0.52% | 0.85% | 0.43% |

# The Ratio of Capital Service per Manhour



# 2. Analytical Framework（1）

- **The standard neoclassical theory states that capital formation is determined by Tobin's q (=Firm value/Replaced value of capital stock)**
- **Gutierrez and Philippon（2017）and Crouzet and Eberly (2018) tried to explain the declining capital formation and the role of intangibles, using Tobin's q theory with multiple assets (=tangibles +intangibles)**

# 2. Analytical Framework（2）

- **The definition of firm value in the case of two assets.**

$$V_{it} = q_{it}^{T} K_{it}^{T} + q_{it}^{Z} K_{it}^{Z}$$

- **Observable Tobin's q using only tangible assets is**

$$q_{it}^{A} = \frac{V_{it}}{K_{it}^{T}} = q_{it}^{T} + q_{it}^{Z} \frac{K_{it}^{Z}}{K_{it}^{T}}$$

- **As $q_{it}^{A}$ reflects not only the value of tangibles but also intangibles, $q_{it}^{A}$ is not an appropriate explanatory variable of capital formation in tangibles.**

# 2. Analytical Framework（3）

- **The first step of analysis: We regress capital formation in tangibles on $q_{it}^{A}$.**

$$I_{it}^{T}/K_{it}^{T} = \alpha_i + \mu_t + \beta q_{it}^{A} + \gamma' X_{it-1} + \varepsilon_{it}$$

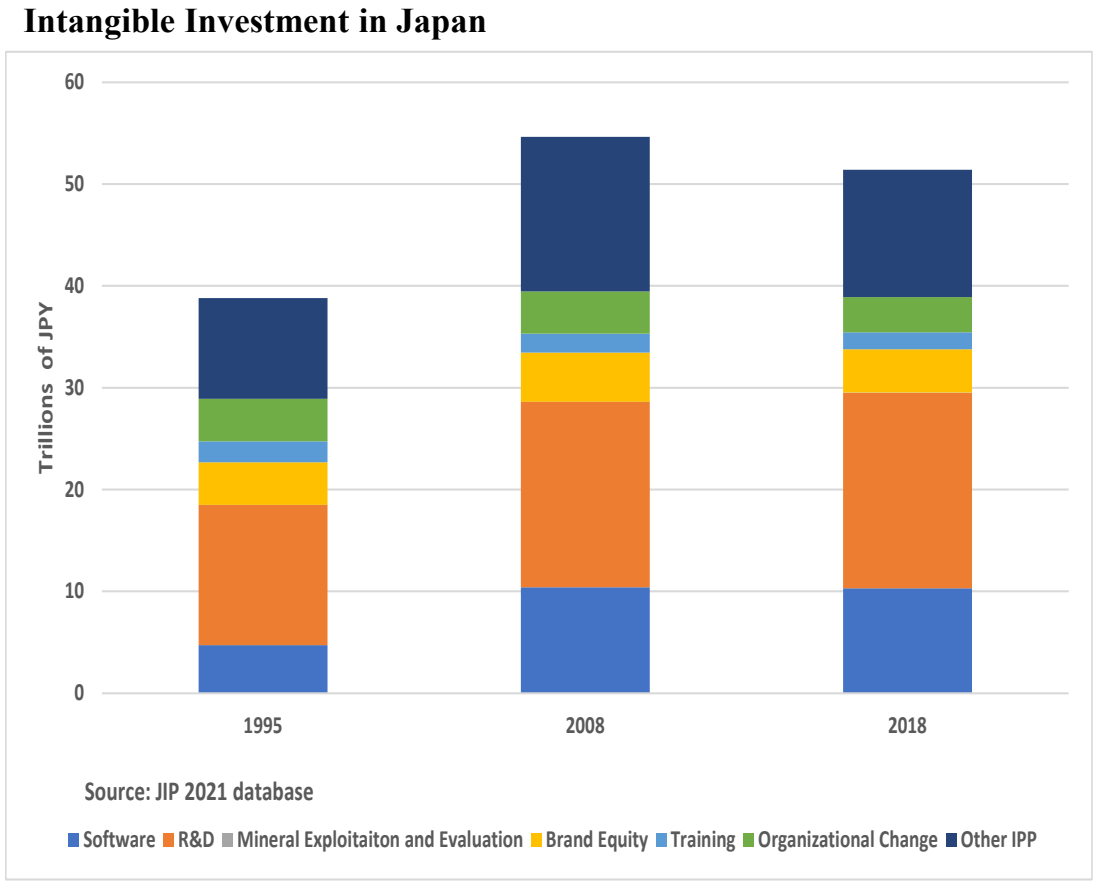
- **This estimation generates a gap between desirable capital formation implied by $q_{it}^{A}$ and real capital formation in tangibles. Coefficients of the time dummies expresses this gap.**
- **In the second step, we regress the coefficients of time dummies on intangibles and other possible explanatory variables (e.g. FDI).**

# 3. Intangibles in Japan (1)

- **Data used for estimation (Tobin's q, capital formation, capital stock in tangibles and intangibles) are constructed from the JIP database (The Japanese KLEMS type dataset) 2021version https://www.rieti.go.jp/jp/database/JIP2021/index.html.**
- **We measure Tobin's q at the industry level by dividing the profit rate by the cost of capital.**
- **To measure the cost of capital we need the following data: interest rate of a safe asset (government bonds), the deflator of capital formation and the corporate tax rate. We obtain the interest rate of government bonds from the IMF database. The deflator of capital formation is obtained from the JIP database. The corporate tax rate is calculated from the OECD corporate income tax revenue.**

# 3. Intangibles in Japan (2)

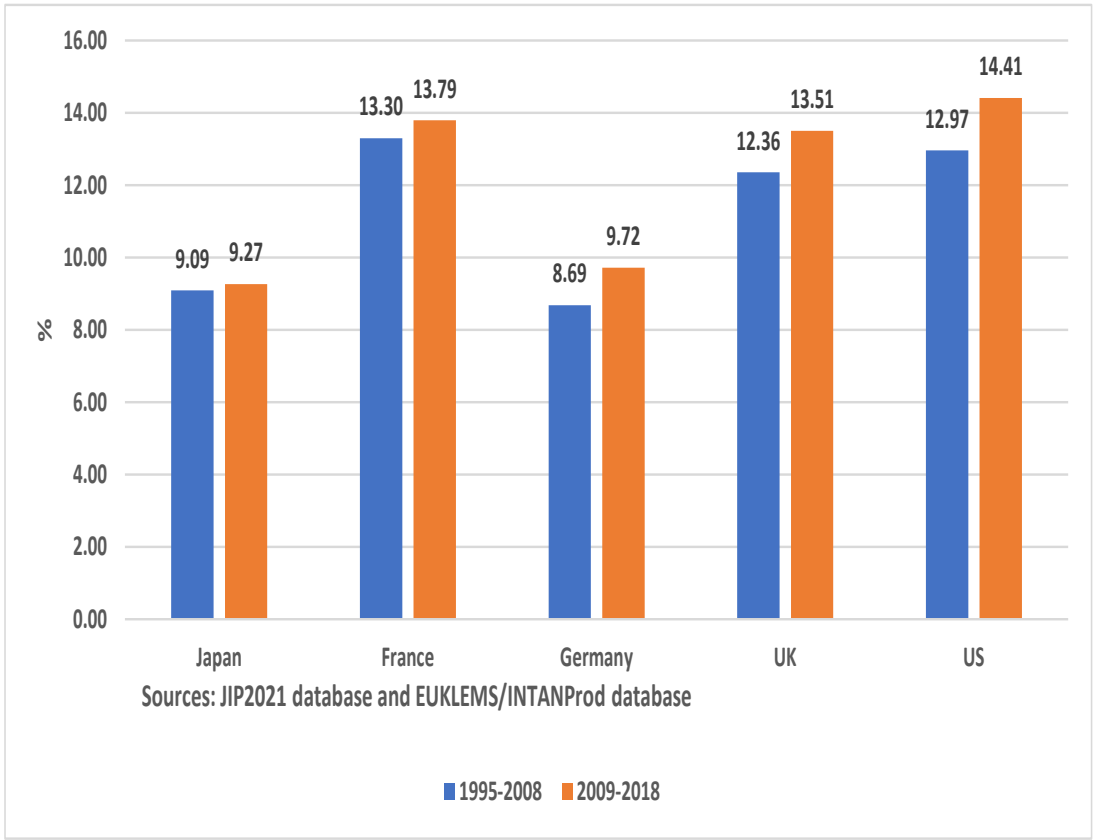
- **Japanese intangible investment defined by Corrado, Hulten and Sichel was about JPY 51 trillion (357 billion Euros). It has increased by 0.7% per year since 1995.**



# 3. Intangibles in Japan (3)

- **Intangible investment/GDP ratio in Japan is 9%. It is almost equal to that in Germany and less than those in France, UK and US.**

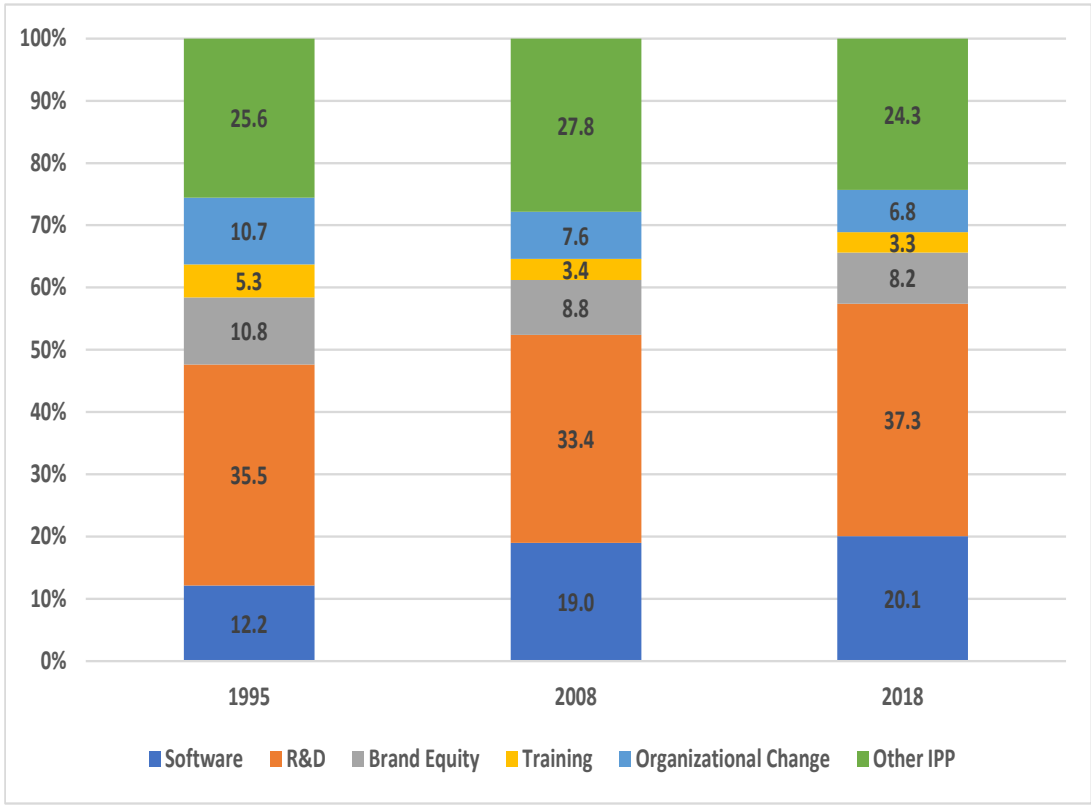
## The Ratio of Intangible Investment to GDP



# 3. Intangibles in Japan (4)

- **The share of R&D in the total intangible investment in Japan is greater than other countries.**
- **However, the share of training in Japan is much lower than other countries.**

**Share of Each Intangibles**



# 4. Estimation Results（1）

- **Estimation in Step 1: We classify 100 industries in the JIP database into 21 sectors. For each sector, we estimate the equation in Slide 7.**
- **From these estimations, we obtain the coefficients of time dummies that are dependent variables in Step 2.**
- **Estimation in Step 2: We regress coefficients of time dummies on the ratio of intangible assets to tangible assets and other control variables (HHI or FDI).**
- **When the coefficient of intangibles/tangibles ratio is negative, intangible investment plays the role of shrinking the gap between capital formation expected from firm value and real capital formation in tangibles.**

# 4. Estimation Results（2）

- **The negative and significant coefficients on intangibles/tangibles ratio imply that intangible investment plays the role of preventing decline in capital formation and contributing to an increase in firm value.**
- **Among intangibles, software investment shrinks the gap between desirable capital formation from firm value and the declining capital formation.**
- **The Herfindahl index and foreign direct investment do not explain the movements of the gap between the desirable investment and the capital formation in tangibles.**
- **Estimation results in the manufacturing sector are similar to those in all industries. However, in the service sector, we do not find negative and significant coefficients on intangibles/tangibles ratio.**

**Table 4 Estimations in the Second Step (all industries)**

| | [1] | [2] | [3] | [4] |
|---|---|---|---|---|
| Intangible/Tangible | **-6.3568*** | | **-7.1306*** | |
| | (2.9423) | | (3.4056) | |
| R&D/Tangible | | **-3.5139** | | **-4.9995** |
| | | (2.3399) | | (2.9281) |
| Software/Tangible | | **-33.2449**** | | **-29.1374***** |
| | | (14.7694) | | (9.0530) |
| HHI | | | **11.9184** | **12.7273** |
| | | | (14.3467) | (13.9518) |
| FDI/Total Investment | | | **0.1583** | **0.3643** |
| | | | (1.0912) | (1.0960) |
| Const. | -0.6215 | -0.4703 | -3.4723 | -3.5465 |
| | (0.8427) | (0.5641) | (3.5403) | (3.4221) |
| Industrial dummy | Yes | Yes | Yes | Yes |
| R-squared | | | | |
| Within | 0.0301 | 0.0409 | 0.0420 | 0.0491 |
| Between | 0.2430 | 0.1789 | 0.0709 | 0.0327 |
| Overall | 0.1757 | 0.1212 | 0.0479 | 0.0217 |
| Number of Observations | 308 | 308 | 300 | 300 |
| Number of Groups | 14 | 14 | 14 | 14 |

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively. Robust standard errors are in parentheses.

# 4. Estimation Results（3）

- **Even when we conduct estimations in Step 2 using intangibles defined by Corrado, Hulten and Sichel (2009), we find negative and significant coefficients on intangibles/ tangibles ratio in all cases.**
- **In the estimation results dividing total intangibles into three types of intangibles (R&D, software, and other intangibles), we find negative and significant coefficients on software in the case of manufacturing and on other intangibles in the case of the service sector.**

**Estimation Results Using Intangibles Defined by Corrado, Hulten and Sichel**

| | All industries | | Manufacturing sector | | Service sector | |
|---|---|---|---|---|---|---|
| Intangible/Tangible | **-7.3930*** | | **-6.6034*** | | **-91.8479**** | |
| | (0.4133) | | (3.4666) | | (23.8788) | |
| R&D/Tangible | | **-4.9881*** | | **-4.4751** | | **-417.152** |
| | | (2.5514) | | (2.8740) | | (318.8933) |
| Software/Tangible | | **-53.6374***** | | **-33.2362**** | | **-32.5585** |
| | | (19.4934) | | (10.0653) | | (71.5222) |
| Other Intangibles/Tangible | | **-20.7948** | | **-7.0426** | | **-61.7661**** |
| | | (14.9570) | | (14.3271) | | (19.4381) |
| Const. | 0.4133 | 2.6423 | 2.7224 | 3.0064 | 4.8256 | 6.6452* |
| | (1.4021) | (2.3732) | (1.8699) | (2.9514) | (2.6394) | (2.4786) |
| Year dummy | No | No | No | No | No | No |
| Industrial dummy | Yes | Yes | Yes | Yes | Yes | Yes |
| R-squared | | | | | | |
| Within | 0.0307 | 0.0513 | 0.0418 | 0.0564 | 0.1049 | 0.1331 |
| Between | 0.2613 | 0.1950 | 0.1184 | 0.0380 | 0.1091 | 0.0093 |
| Overall | 0.1935 | 0.1419 | 0.0628 | 0.0161 | 0.0757 | 0.0119 |
| Number of Observations | 308 | 308 | 198 | 198 | 110 | 110 |
| Number of Groups | 14 | 14 | 9 | 9 | 5 | 5 |

Note: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively. Robust standard errors are in parentheses.

# 5. How much of the gap between desirable capital formation and actual capital formation is filled by intangible investment?

- Using the coefficients in the previous estimation results ([1]), we measure how intangible investment fills the gap between desirable capital formation and actual tangible capital formation.
- Our calculation shows that 42% of the gap is filled by intangible investment, while 67% of the gap is filled in the case of Crouzet and Eberly (2018)

# 6. Summary and Further Discussions（1）

- **Low growth in Japan in the 2010s is not caused by low TFP growth, but by the low capital accumulation rate.**
- **Following Gutierrez and Philippon（2017）and Crouzet and Eberly (2018), we examine how intangible investment prevent the declining capital formation in tangibles.**
- **Intangible investment fills 42% of the gap between desirable investment and actual tangible investment.**
- **These results imply that intangible investment contributes to the increase in firm value.**
- **However, we believe that there are still other invisible assets that contribute to the firm value.**

# 6. Summary and Further Discussions（2）

- **We obtained a similar result using EUKLEMS 2019 database and INTAN-Invest database. We will try to conduct the same estimations using EUKLEMS/INTANProd database.**
- **We will also apply our analytical framework to firm-level data, although we obtain only R&D data as intangibles.**

**Thank you very much for your attention**

**We welcome your comments!**

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