ISBSG
Improving IT Performance

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Validity evaluation model for cost estimation based on various software metrics

JFPUG
Japan Function Point User Group

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Content (1/2)

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- Scatter plot of FP and effort
- Double logarithmic plot
- Productivity classification map
- Map with regression line
- Two-factor logarithmic plot by category
- Productivity Factors and Modeling

Content (2/2)

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- Distribution pattern and model optimization
- Evaluation of Productivity improvement
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Definition of software productivity

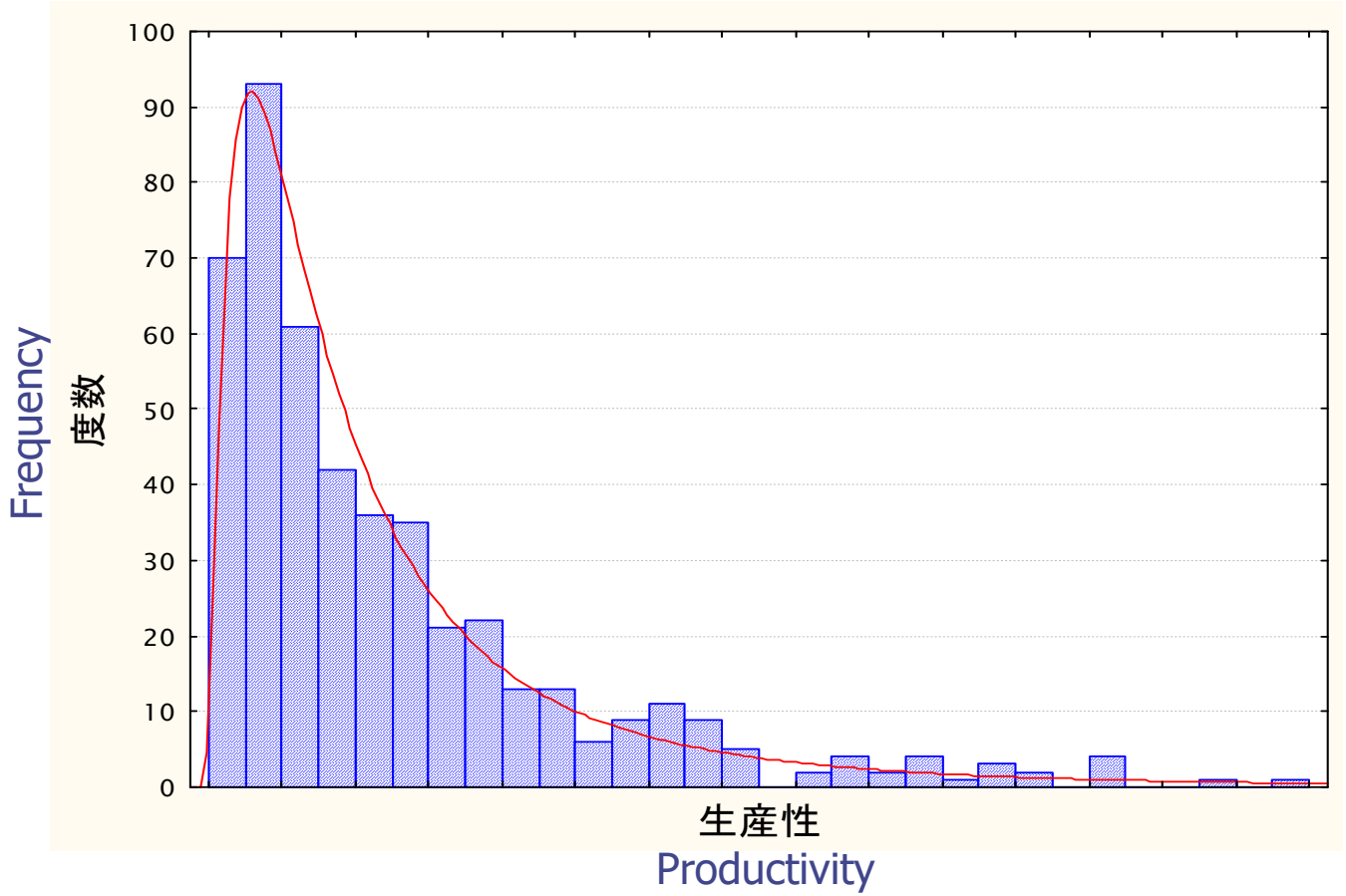
$$FP\ Productivity = \frac{Function\ Point}{Person\ Month} = \frac{FP}{PM}$$

$$ex.\quad P_F = \frac{1000}{100} = 10\ [\mathrm{FP}/\mathrm{PM}]$$

$$SLOC\ Productivity = \frac{Source\ Line\ of\ Code}{Person\ Hour} = \frac{SLOC}{PH}$$

$$ex.\quad P_S = \frac{100{,}000}{100\times160} = 6.25\ [SLOC/\mathrm{PH}]$$

Distribution of productivity (1/2)

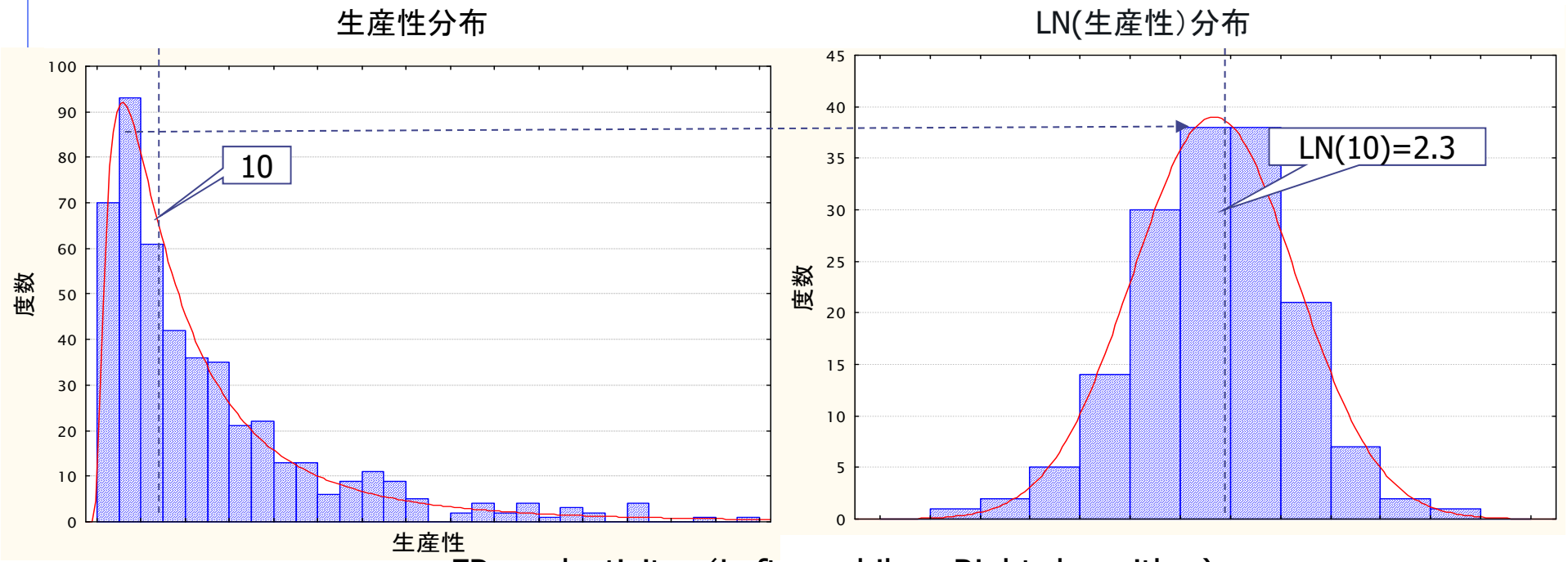


1. Productivity has a long distribution. Therefore, the criteria for low productivity or high productivity can not be clarified.
2. We can not determine the criteria for detecting productivity outliers.

Distribution of productivity (2/2)

The logarithm of productivity has the property of following a normal distribution.

Treating as a normal distribution makes it possible to utilize the knowledge of statistical analysis。



FP productivity （Left: unchilog、Right: logarithm)

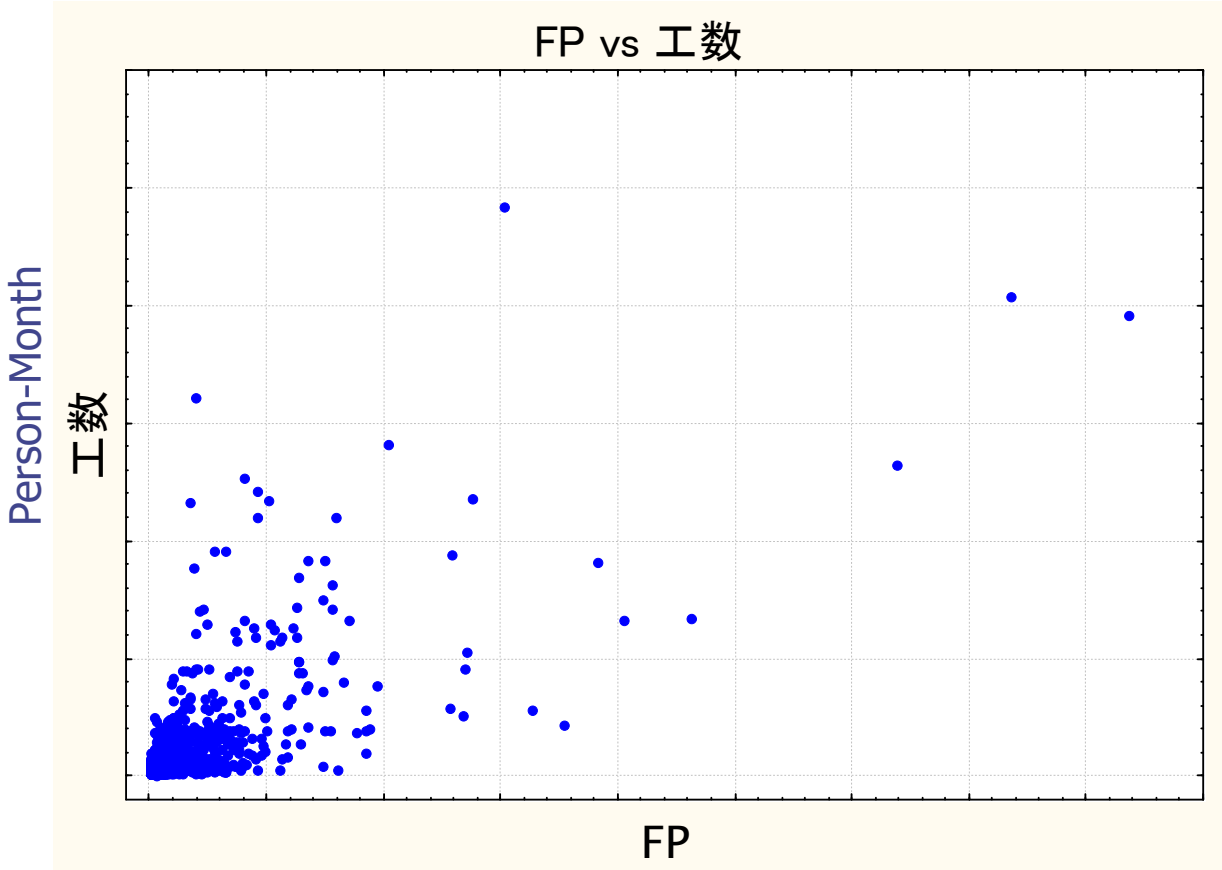
【Example of calculation】

The natural logarithm of FP productivity 10 [FP /PM] is LN (10) = 2.3. What is the distribution of natural logarithm LN (productivity) of productivity?

【Result of analysis】

The logarithm of productivity (FP) is a bell-shaped distribution, and it has been confirmed that the distribution follows a normal distribution.

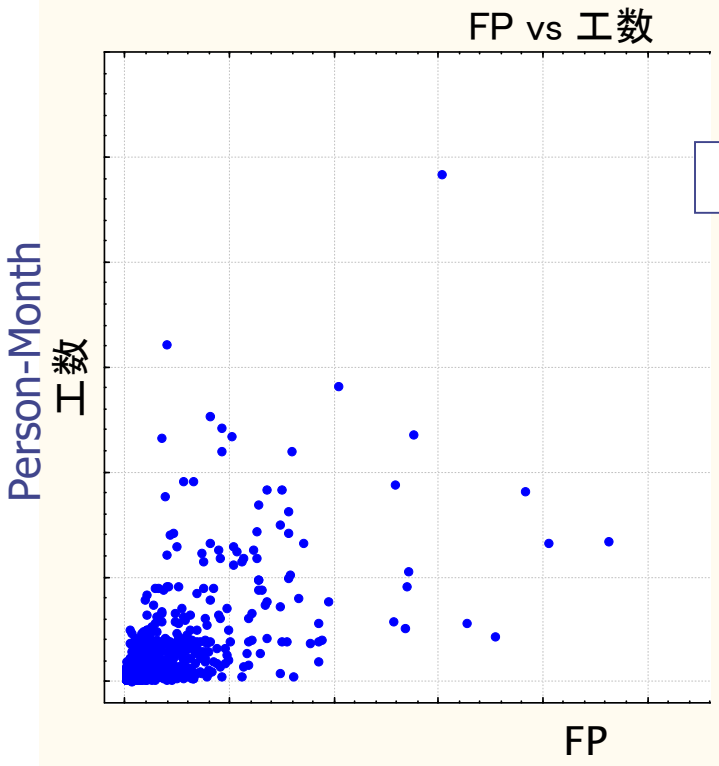
Scatter plot of FP and effort (1/2)



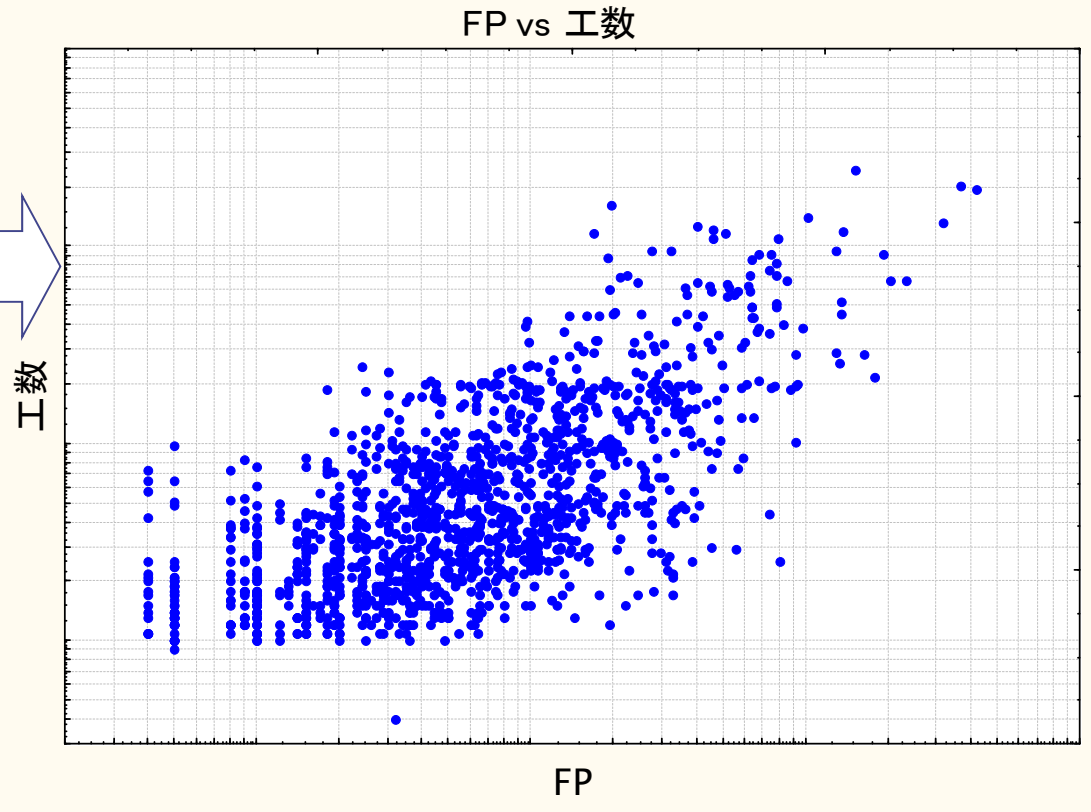
When the whole is displayed, in the small-scale project part, the plots are concentrated and the distribution situation can not be grasped. In addition, the same form appears even if you exclude large-scale projects that seem to be outliers.

Scatter plot of FP and effort (2/2)

Scatter plot



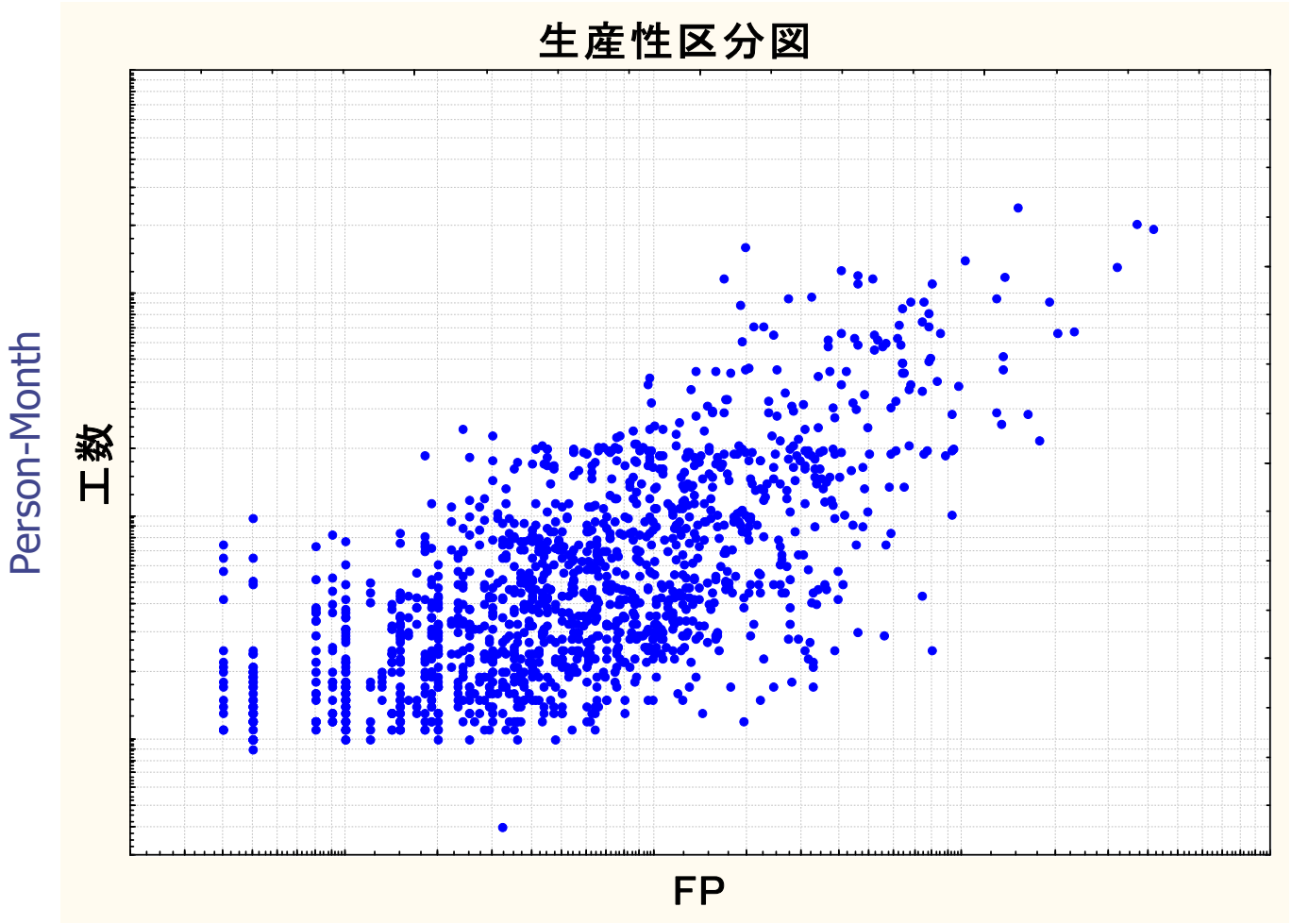
Double logarithmic plot



Plot the project data on a log-log scatter plot to understand the distribution situation

The logarithmic value has no meaning. Understand that variable transformation is a means to understand relationships.

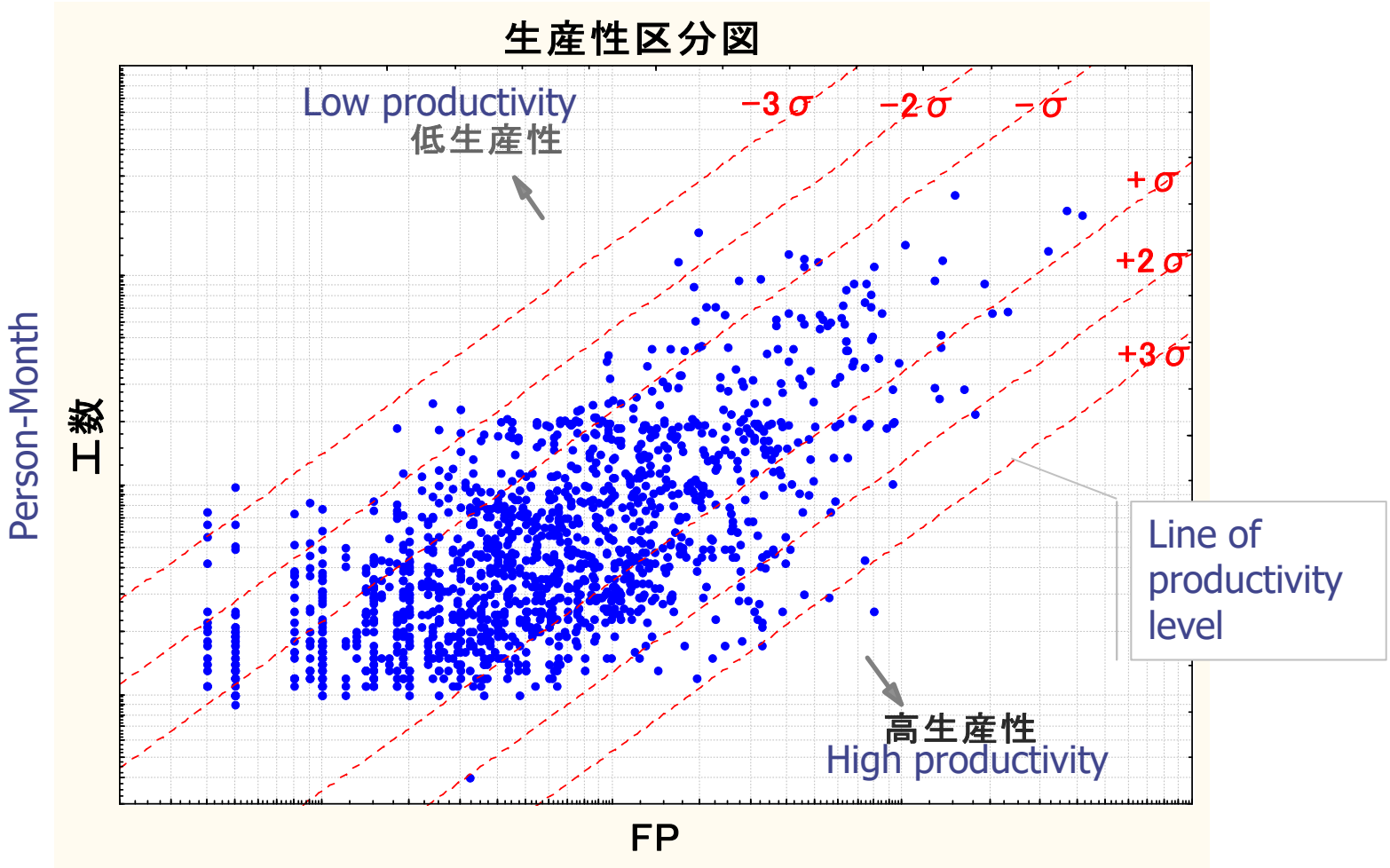
Double logarithmic plot



Statistical regularity can be confirmed by taking logarithms of FP and effort.

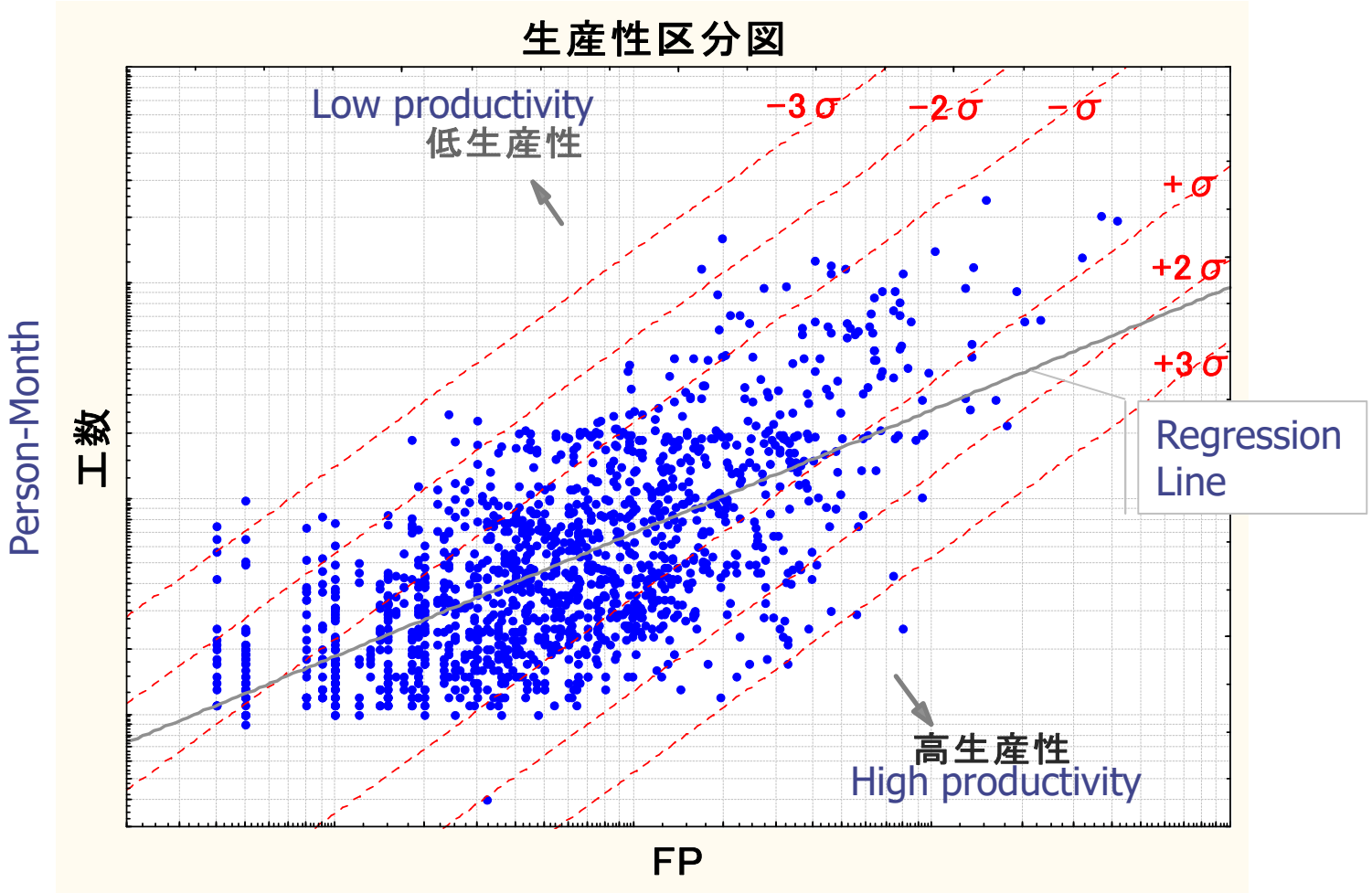
Note: In this example, only projects with a certain number of costs or more are targeted for FP measurement.

Productivity classification map



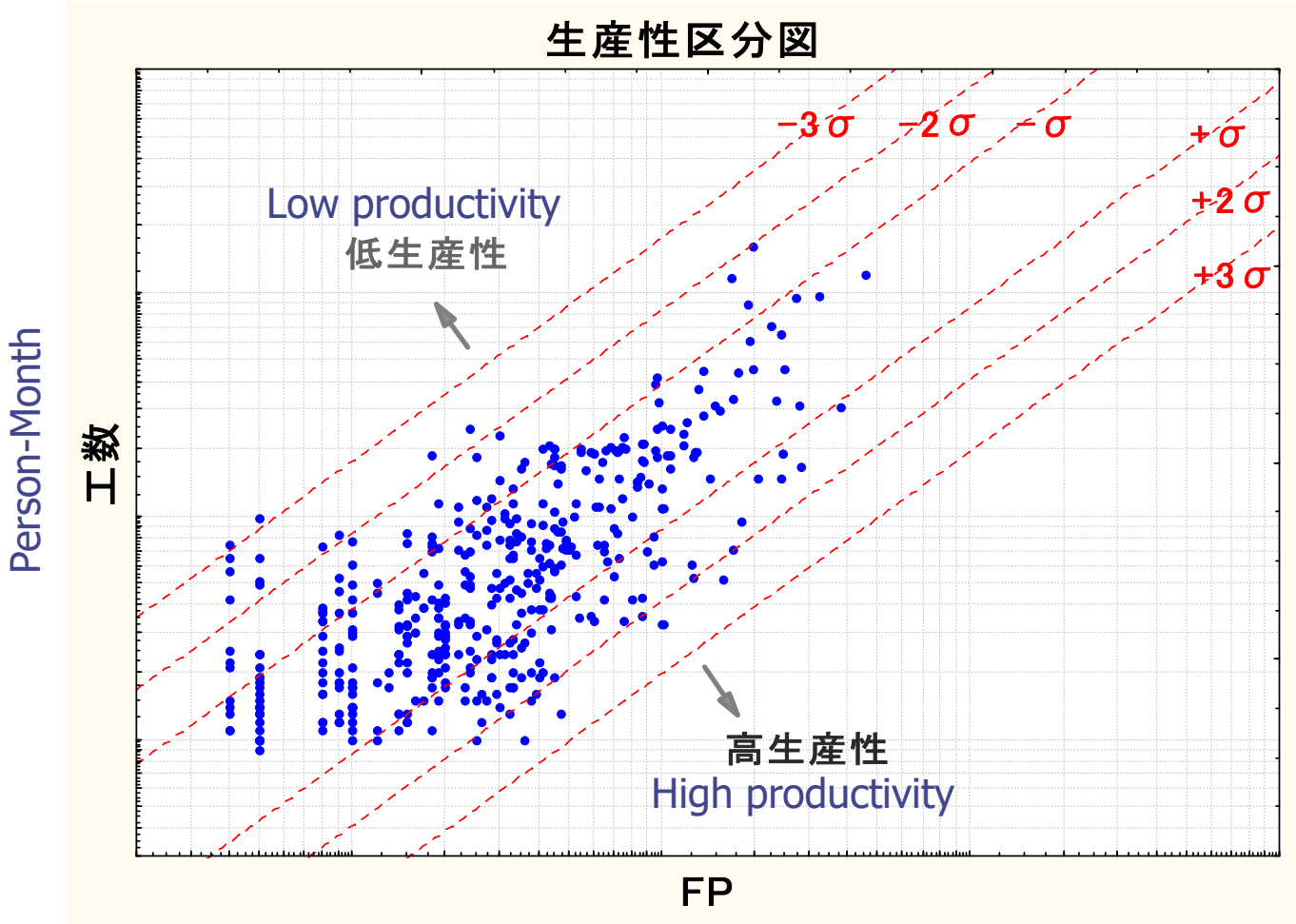
Plotting a line that divides productivity into a double-log scatter plot makes it easier to identify the distribution pattern of productivity.

Map with regression line



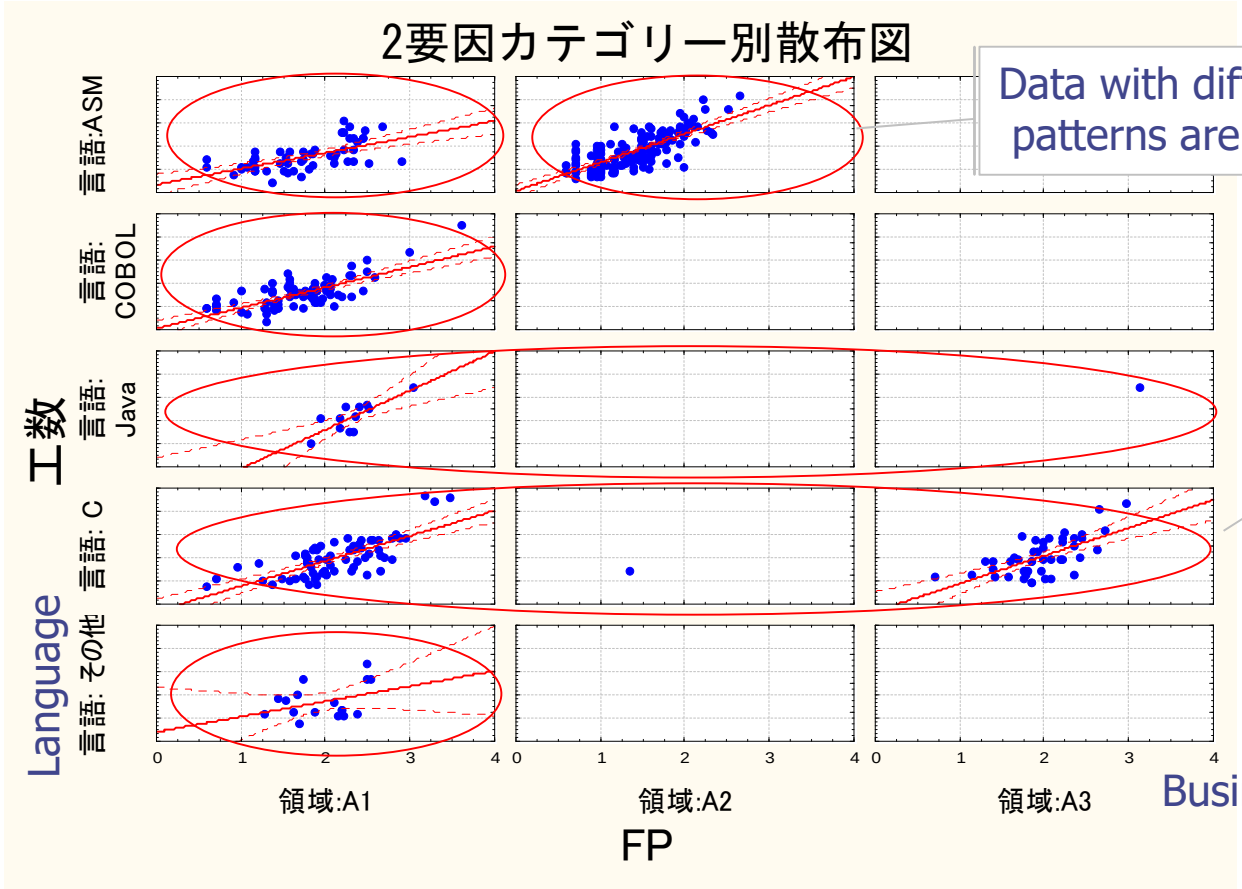
It may be concluded that the larger the scale, the higher the productivity.
(The paradox of regression to the mean)

Productivity classification map (Area: A2)



Specific work areas occupy specific areas of the scatter plot.
(Requires classification analysis)

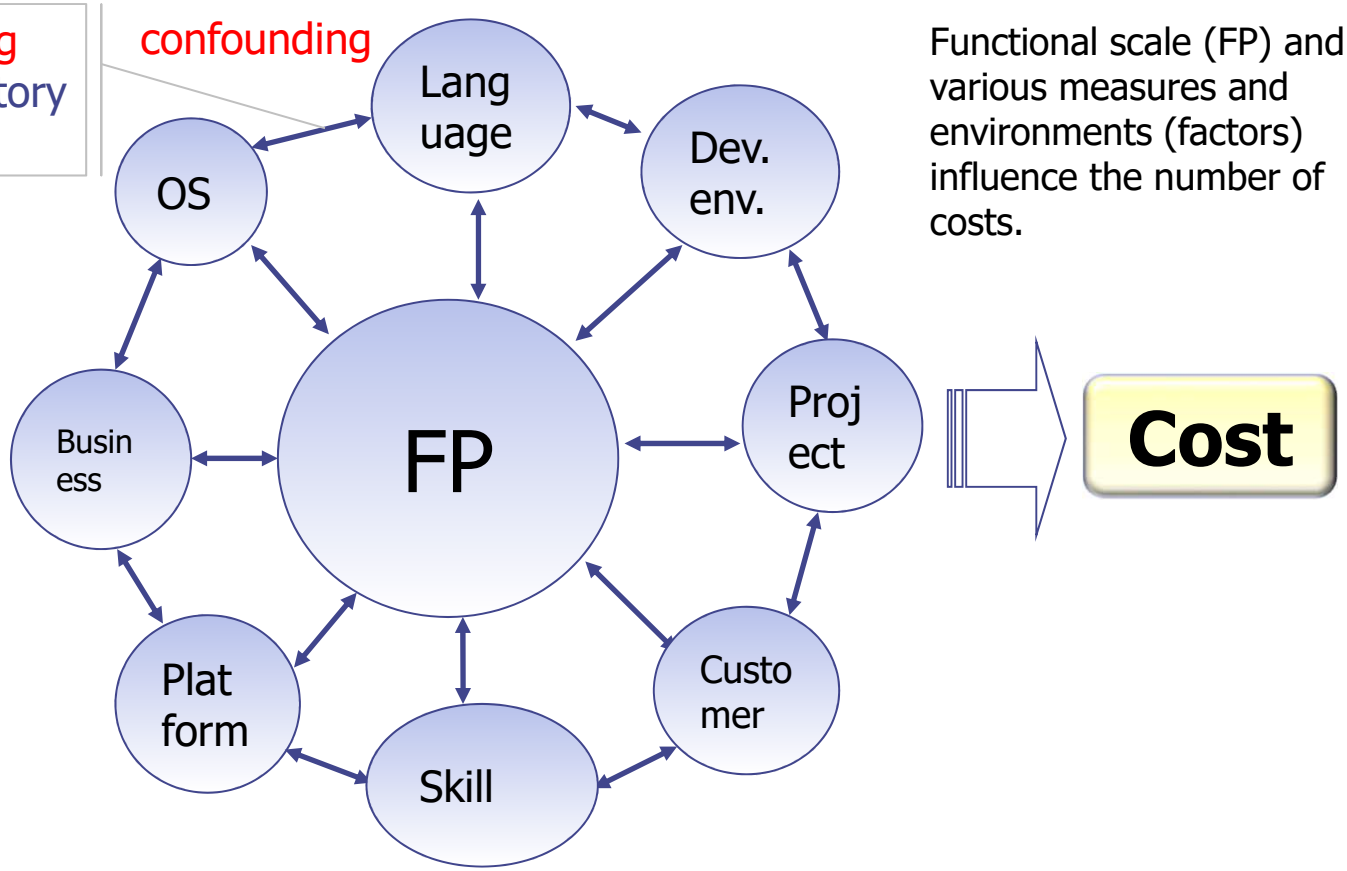
Two-factor logarithmic plot by category



1. The data is multidimensional, so simple classification can not explain the reality correctly.
2. Find factors that are dense (or sparse) by combining the factors to create a scatter plot.

Productivity Factors and Modeling (1/2)

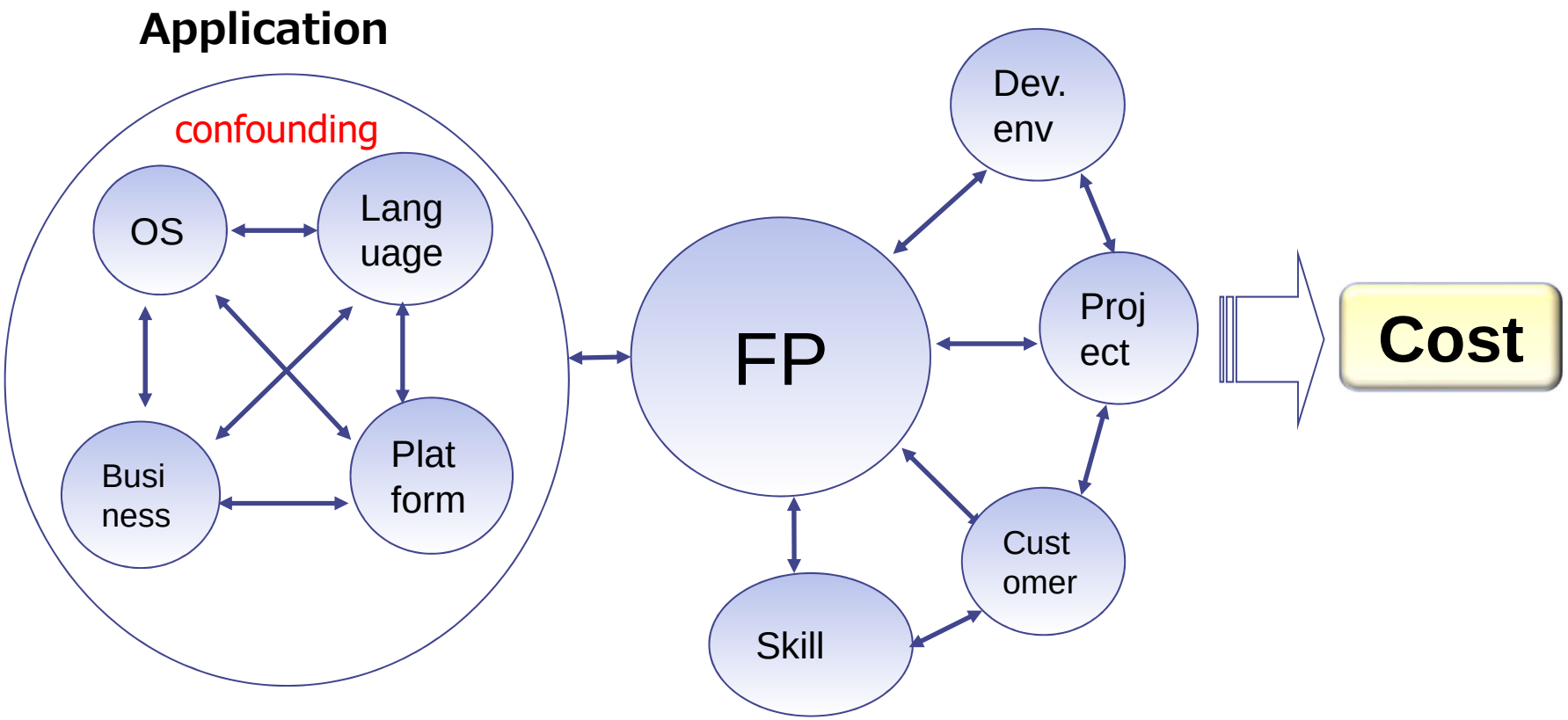
There is a confounding between the explanatory variables



Functional scale (FP) and various measures and environments (factors) influence the number of costs.

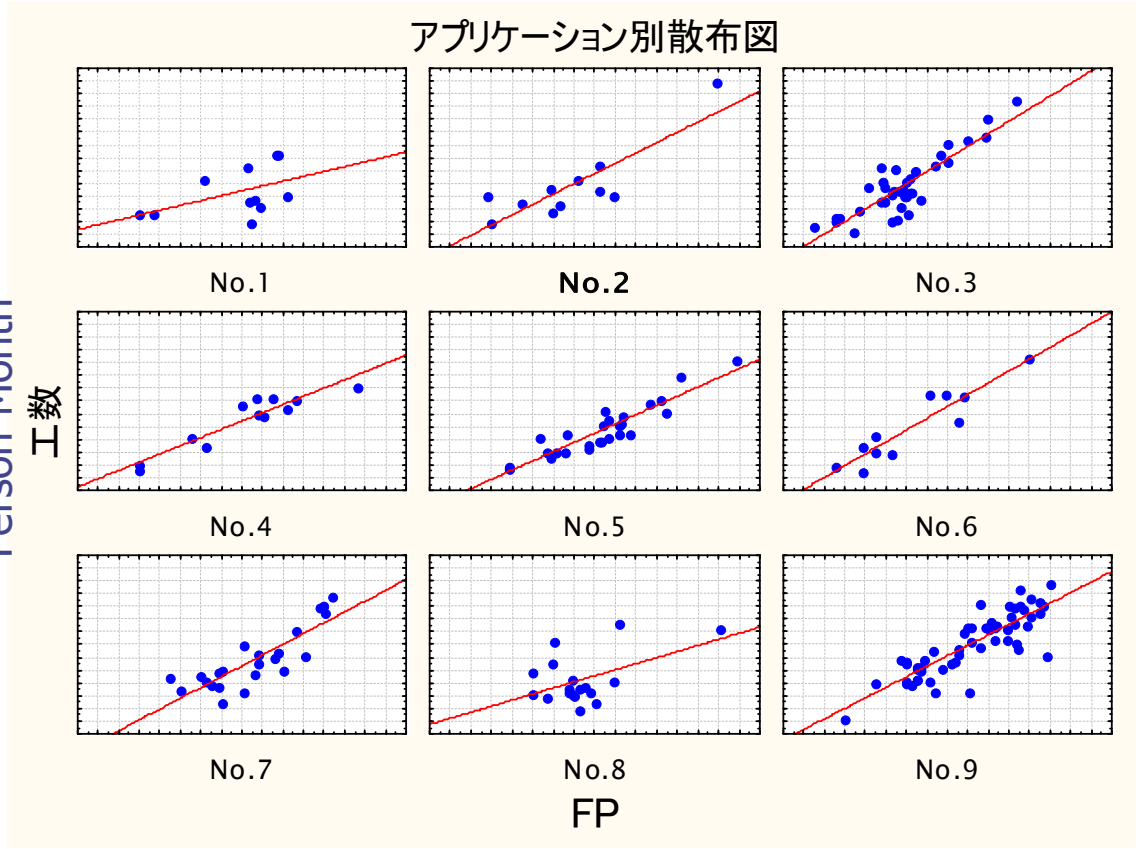
1. Understand the relationship between factors and create a model that best describes the relationship between FP and costs.
2. If there are confounding factors, the effects of the factors may not be separated.

Productivity Factors and Modeling (2/2)



Application-centric grouping enables analysis to proceed without separating the effects of interactions.

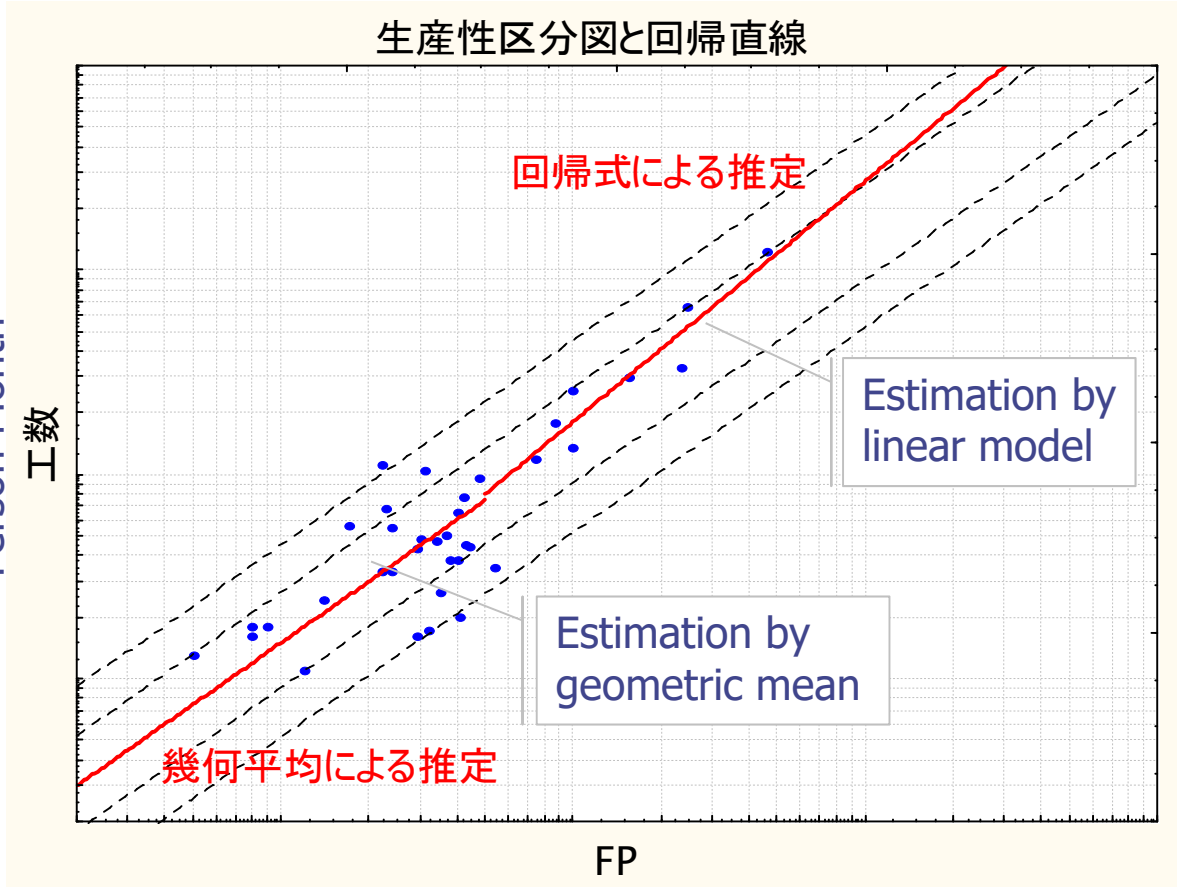
Application-specific scatter plots



No.	R^2	Regression	
		a	b
1	14%	0.833	0.379
2	69%	0.216	0.807
3	75%	0.165	0.982
4	86%	0.395	0.645
5	84%	0.177	0.724
6	84%	0.183	0.926
7	69%	0.150	0.845
8	20%	0.577	0.475
9	71%	0.238	0.824

1. Application classification also reflects non-functional requirements, often with high correlation between FP and effort.
2. Observe distribution patterns and examine whether regression equations are applicable.
3. Adjust the degree of freedom adjustment factor of 50% or more as the basis for adopting regression formula. (Determining factor: percentage that can explain costs with FP)

Distribution pattern and model optimization



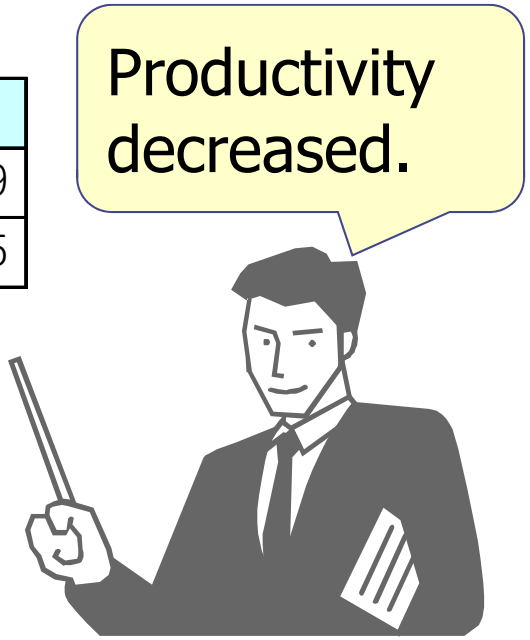
As a result of examination by pattern recognition, in small scale (less than 60 FP), estimation by geometric mean can be considered, and in medium and large scale (60 FP or more), estimation by regression analysis can be considered.

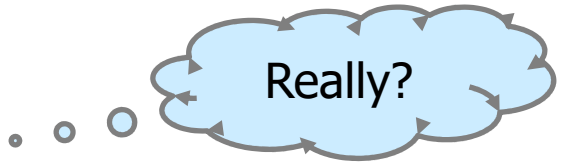
Evaluation of Productivity improvement (1/2)

Year	Business Area	FP	Effort(PM)	Productivity
2014	X	1000	240	4.2
	Y	1000	50	20.0
2015	X	4000	890	4.5
	Y	1200	48	25.0

Summary by Year

Year	Business Area	FP	Effort(PM)	Productivity
2014	X and Y	2000	290	6.9
2015	X and Y	5200	938	5.5





Evaluation of Productivity improvement (2/2)

Business Area	Year	FP	Effort(PM)	Productivity
X	2014	1000	240	4.2
	2015	4000	890	4.5
Y	2014	1000	50	20.0
	2015	1200	48	25.0

How much did productivity increase overall?

Work efficiency Evaluation model (1/3)

The effort evaluation model calculates the "desired effort" that reflects the characteristics of the project, based on the benchmark and the baseline from in-house results. Since this effort is a standard effort that reflects the past results.

Actual or efficiency should be assessed relative to this standard effort.

$$Work\ efficiency = \frac{Standard\ effort}{Actual\ effort}$$

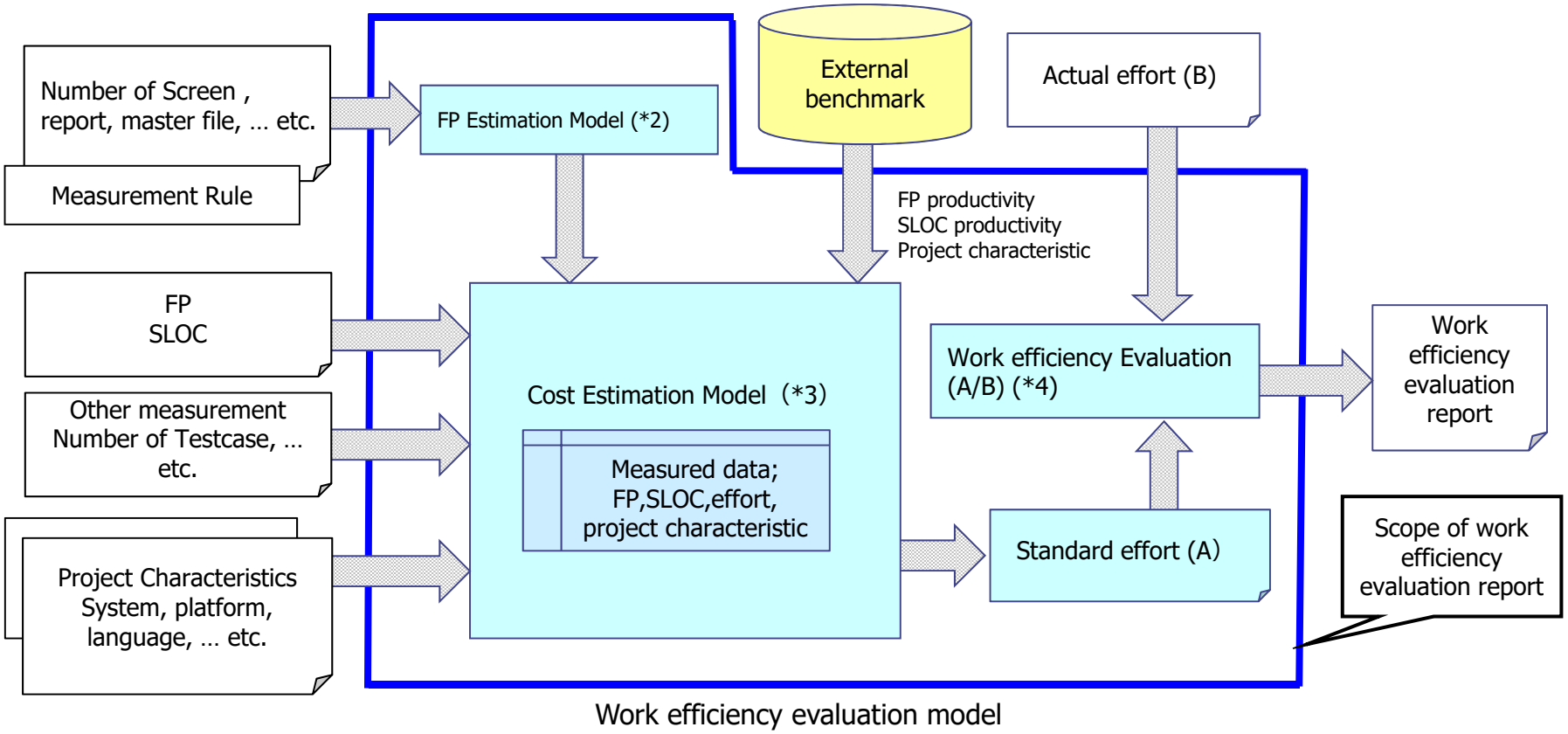
Management of productivity based on work efficiency is more flexible than management based on FP productivity because it is possible to flexibly add an explanatory factor.

Work efficiency Evaluation Model (2/3)

Year	Buz_Area	FP	Actual Effort (B)	Standard Productivity	Standard Effort (A)	Saving (A-B)	Note
2014	X	1000	240	4.2	-	-	Baseline
	Y	1000	50	20.0	-	-	Baseline
2015	X	4000	890	4.2	960	70	
	Y	1200	48	20.0	60	12	
Total		5200	938		1020	82	

Work Efficiency	1.09	(=1020/938)

Work efficiency Evaluation Model (3/3)



*1: Customize measurement rules such as screen and number of forms according to your situation (FP physical function identification method).
The introduction of this method enables evaluation at the initial stage of the project.

*2: If accumulation of actual data is insufficient, use the FP approximation model with reference to the external benchmark.

*3: Based on the analysis results of the actual data, determine the optimal classification, and build a cost model that also reflects the findings from the external benchmark.

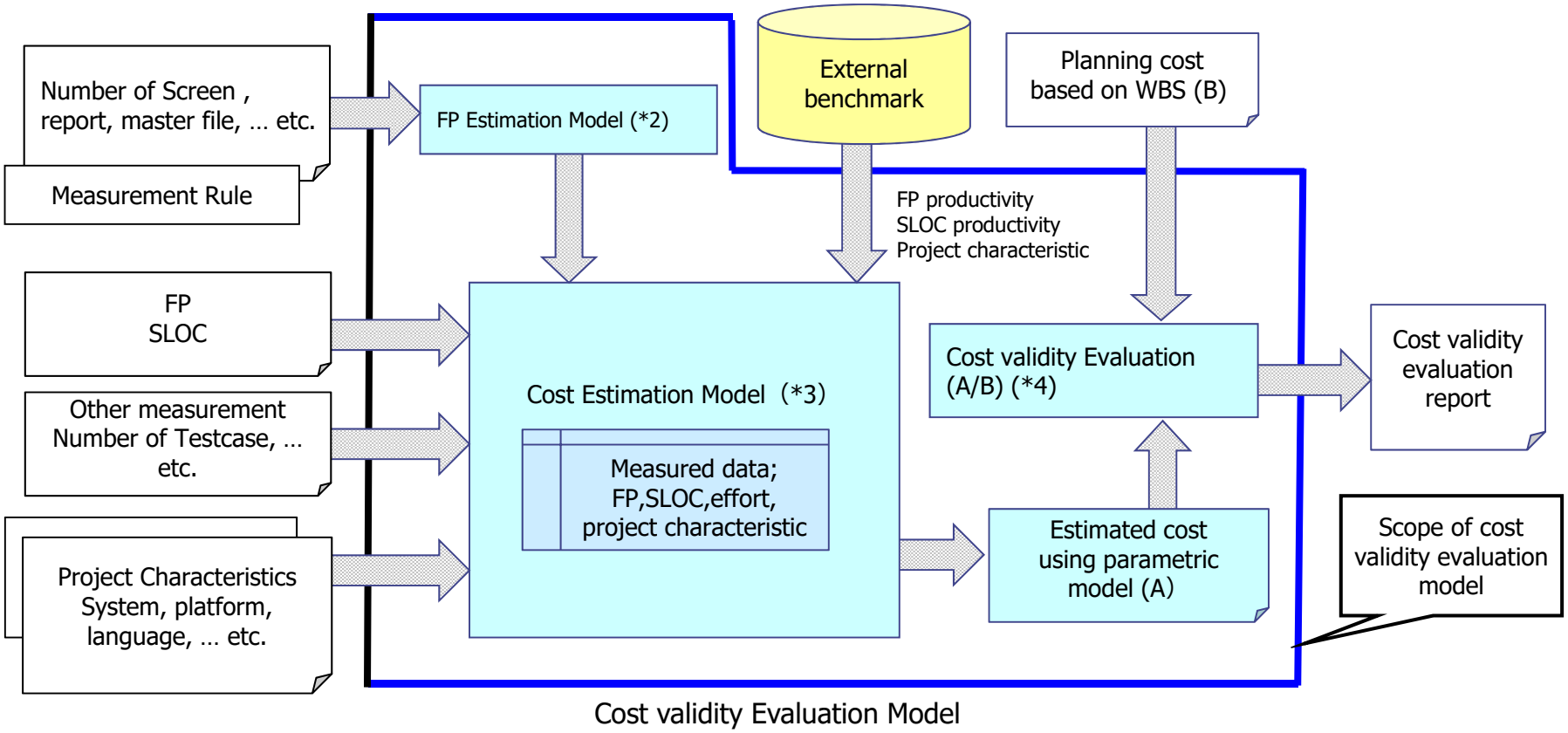
*4: Visualize deviations from standard effort and evaluate project efficiency.

Cost validity Evaluation Model（1/2)

- The purpose of planned cost evaluation is to compare the costs estimated by accumulation by WBS with the predicted costs based on the past results to confirm whether it is a reasonable cost.
- Estimated cost is calculated by the parametric method. This is a different estimation approach from the WBS-based stacked approach, so problems such as missing costs can be detected.
- If the planned costs are too small compared to the estimated costs, check if there is any leak in the plan.
- If the planned costs are excessive compared to the estimated costs, check if there is no waste in the plan or if there are any mistakes in the prediction assumptions.
- "Validity of estimation" is defined as follows in the validity evaluation model of the planning effort.

$$\text{Cost validity} = \frac{Estimated\ cost}{Planning\ cost}$$

Cost validity Evaluation Model (2/2)



Cost validity Evaluation Model

*1: Customize measurement rules such as screen and number of forms according to your situation (FP physical function identification method).
The introduction of this method enables evaluation at the initial stage of the project.

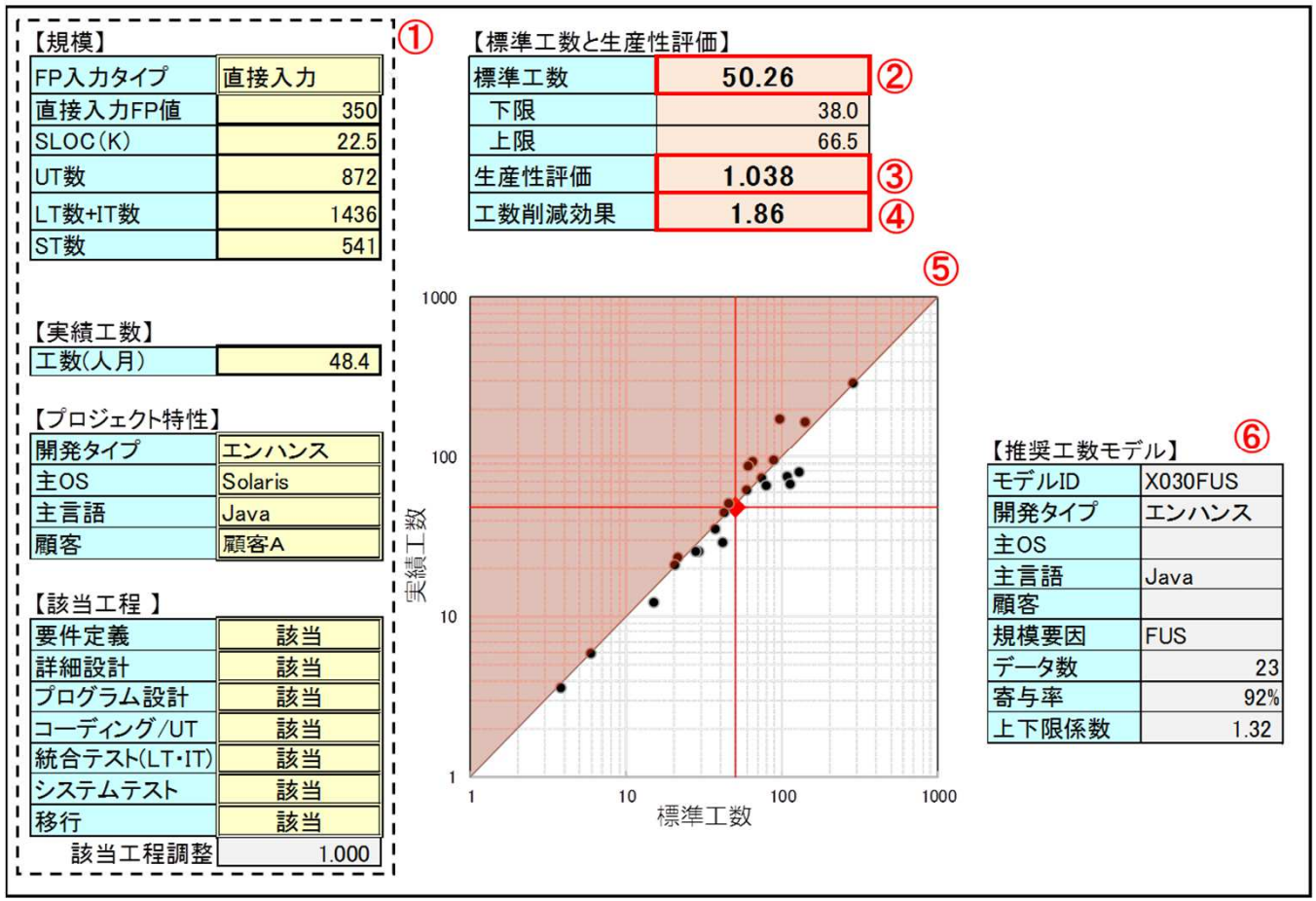
*2: If accumulation of actual data is insufficient, use the FP approximation model with reference to the external benchmark.

*3: Based on the analysis results of the actual data, determine the optimal classification, and build a cost model that also reflects the findings from the external benchmark.

*4: Visualize the deviation from the forecasted effort and determine the appropriateness of the planned effort.

Case study～TOiNX

Eckert Prize won in Unisys Research Group !



【規模】 ①

FP入力タイプ	直接入力
直接入力FP値	350
SLOC(K)	22.5
UT数	872
LT数+IT数	1436
ST数	541

【実績工数】

工数(人月)	48.4

【プロジェクト特性】

開発タイプ	エンハンス
主OS	Solaris
主言語	Java
顧客	顧客A

【該当工程 】

要件定義	該当
詳細設計	該当
プログラム設計	該当
コーディング/UT	該当
統合テスト(LT・IT)	該当
システムテスト	該当
移行	該当
該当工程調整	1.000

【標準工数と生産性評価】

標準工数	50.26	②
下限	38.0	
上限	66.5	
生産性評価	1.038	③
工数削減効果	1.86	④

⑤

【推奨工数モデル】 ⑥

モデルID	X030FUS
開発タイプ	エンハンス
主OS	
主言語	Java
顧客	
規模要因	FUS
データ数	23
寄与率	92%
上下限係数	1.32

① Enter the scale and characteristics.
② Display the estimated standard person-months.
③ Display the evaluation results of productivity. (3.8% improvement)
④ Display the person-months reduction effect. (Reduction of 1.86 person-months)
⑤ Black points indicate past PJ, and red points indicate evaluation PJ.
⑥ Display the regression equation information for which the standard person-months have been calculated.

Ref: Hiroaki Satoh, "Case Study for the Productivity Evaluation of Software Development Projects," UNISYS TECHNOLOGY REVIEW No. 129, SEP. 2016., p22
Note. TOiNX: Tohoku Information Systems Company, Incorporated (http://www.toinx.co.jp/)

Conclusion

- FP productivity follows a lognormal distribution
- FP productivity is not enough to express work efficiency
- Evaluate productivity using work efficiency
- The cost estimation model is multivariate model
- Classification and aggregation in model construction
- Work efficiency evaluation model to evaluate actual cost
- Prediction model and evaluation model are different
- Cost validity evaluation model to evaluate the planned cost