

A tale of two variables

INTRODUCTION TO REGRESSION WITH STATSMODELS IN PYTHON



Maarten Van den Broeck

Content Developer at DataCamp

Swedish motor insurance data

- Each row represents one geographic region in Sweden.
- There are 63 rows.

n_claims	total_payment_sek
108	392.5
19	46.2
13	15.7
124	422.2
40	119.4
...	...

Descriptive statistics

```
import pandas as pd  
print(swedish_motor_insurance.mean())
```

```
n_claims          22.904762  
total_payment_sek  98.187302  
dtype: float64
```

```
print(swedish_motor_insurance['n_claims'].corr(swedish_motor_insurance['total_payment_sek']))
```

```
0.9128782350234068
```

What is regression?

- Statistical models to explore the relationship a response variable and some explanatory variables.
- Given values of explanatory variables, you can predict the values of the response variable.

n_claims	total_payment_sek
108	3925
19	462
13	157
124	4222
40	1194
200	???

Jargon

Response variable (a.k.a. dependent variable)

The variable that you want to predict.

Explanatory variables (a.k.a. independent variables)

The variables that explain how the response variable will change.

Linear regression and logistic regression

Linear regression

- The response variable is numeric.

Logistic regression

- The response variable is logical.

Simple linear/logistic regression

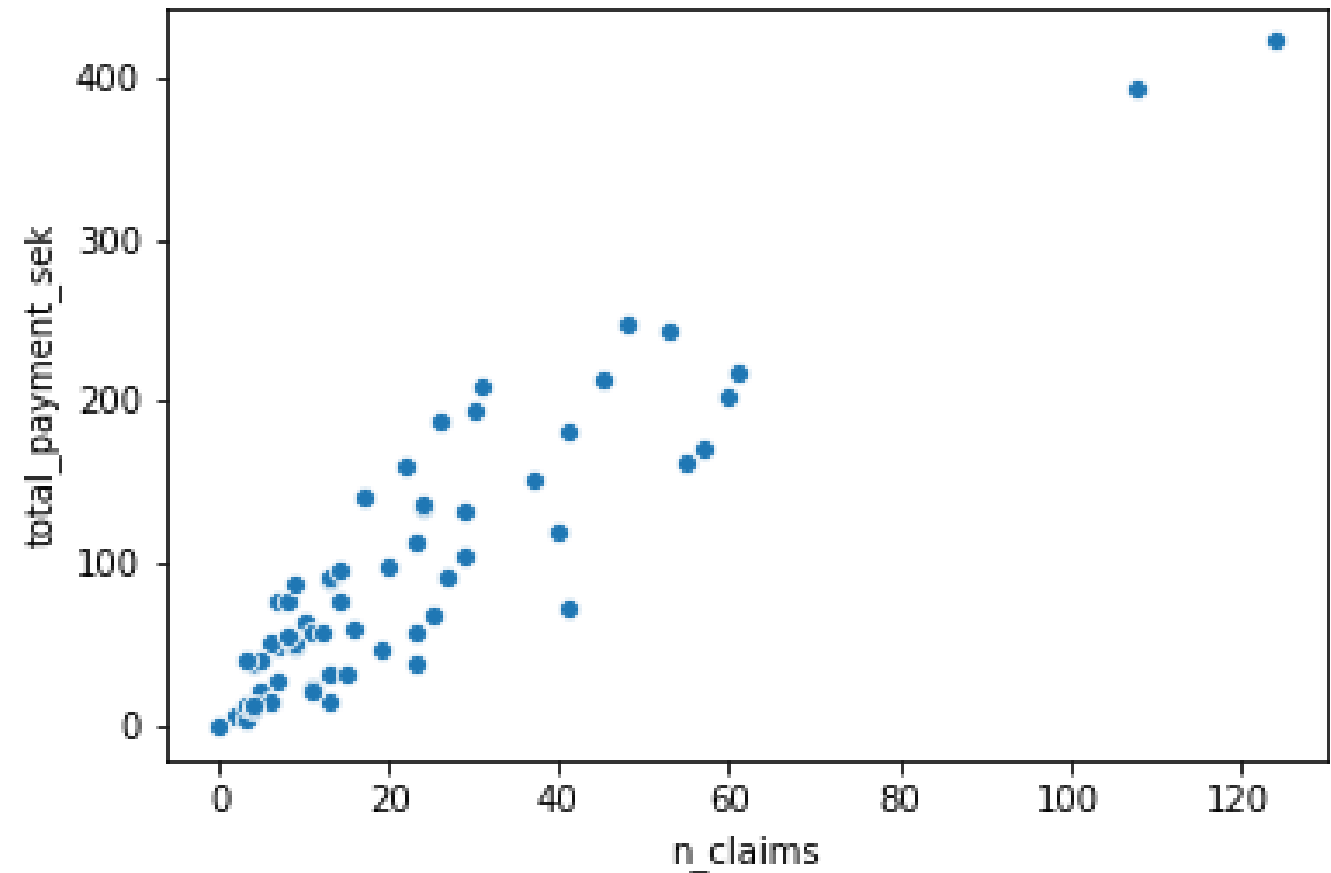
- There is only one explanatory variable.

Visualizing pairs of variables

```
import matplotlib.pyplot as plt
import seaborn as sns

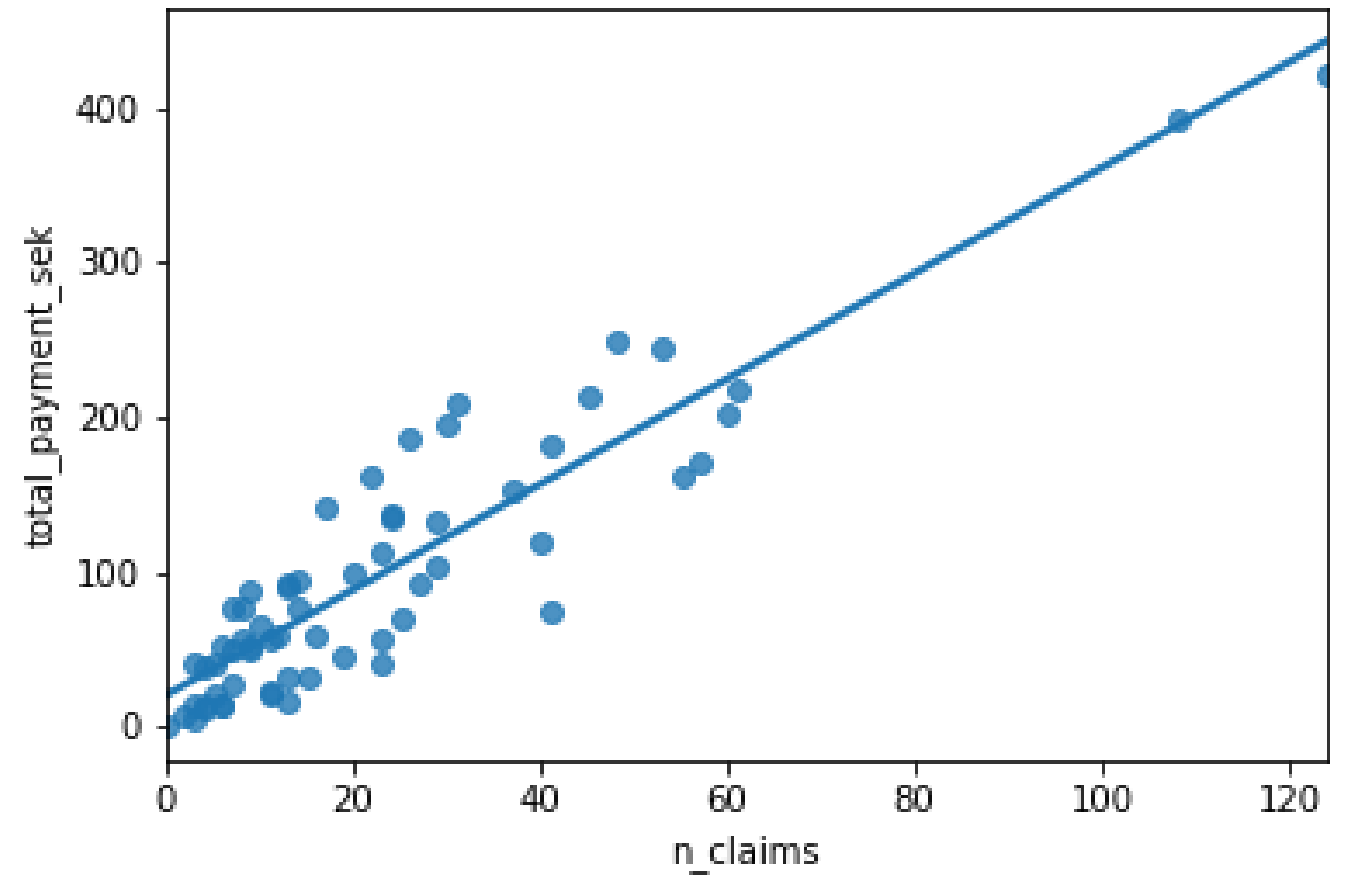
sns.scatterplot(x="n_claims",
                y='total_payment_sek',
                data=swedish_motor_insurance)

plt.show()
```



Adding a linear trend line

```
sns.regplot(x="n_claims",  
            y="total_payment_sek",  
            data=swedish_motor_insurance,  
            ci=None)
```



Course flow

Chapter 1

Visualizing and fitting linear regression models.

Chapter 2

Making predictions from linear regression models and understanding model coefficients.

Chapter 3

Assessing the quality of the linear regression model.

Chapter 4

Same again, but with logistic regression models

Python packages for regression

`statsmodels`

- Optimized for insight (focus in this course)

`scikit-learn`

- Optimized for prediction (focus in other DataCamp courses)

Let's practice!

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Fitting a linear regression

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Straight lines are defined by two things

Intercept

The y value at the point when x is zero.

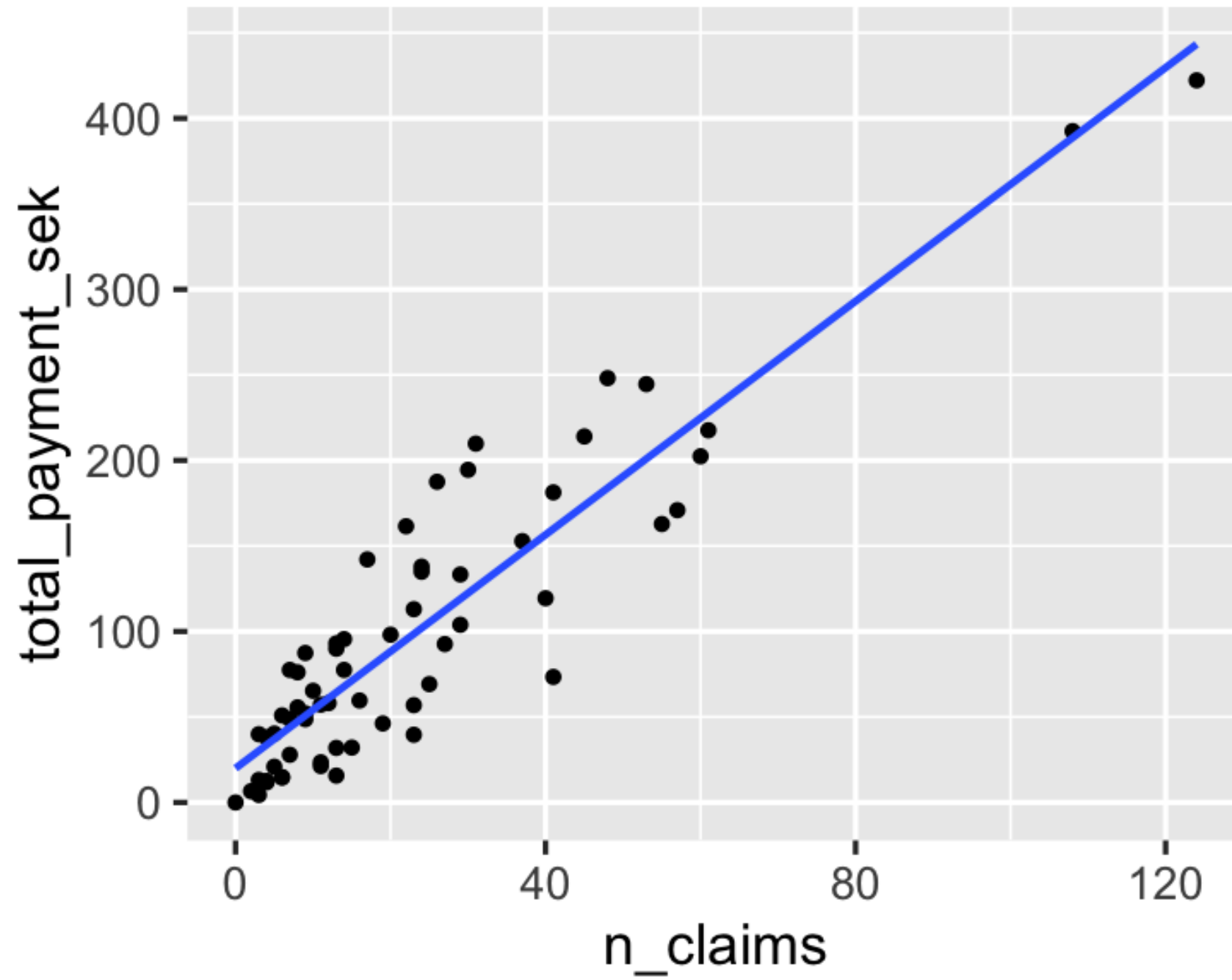
Slope

The amount the y value increases if you increase x by one.

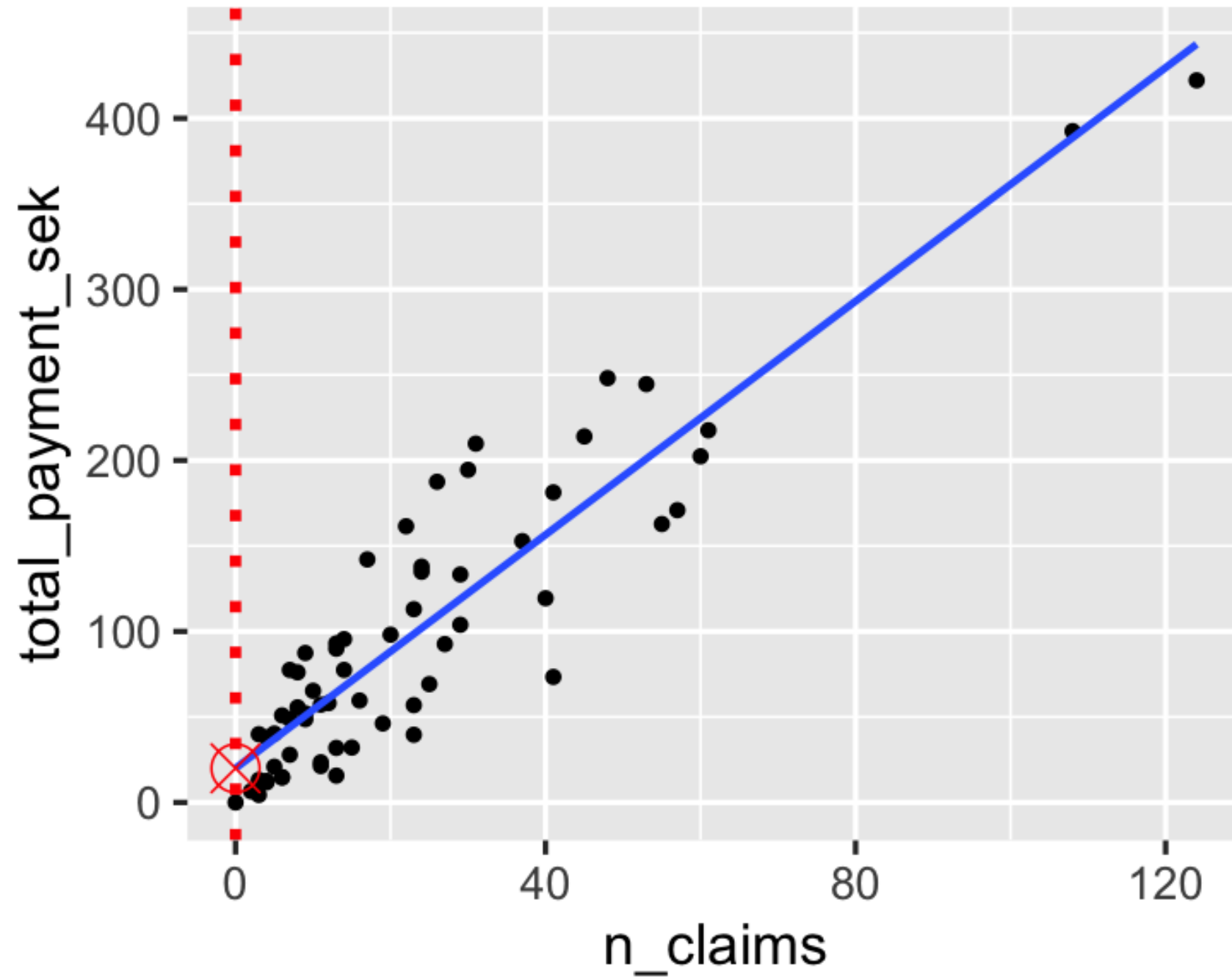
Equation

$$y = \text{intercept} + \text{slope} * x$$

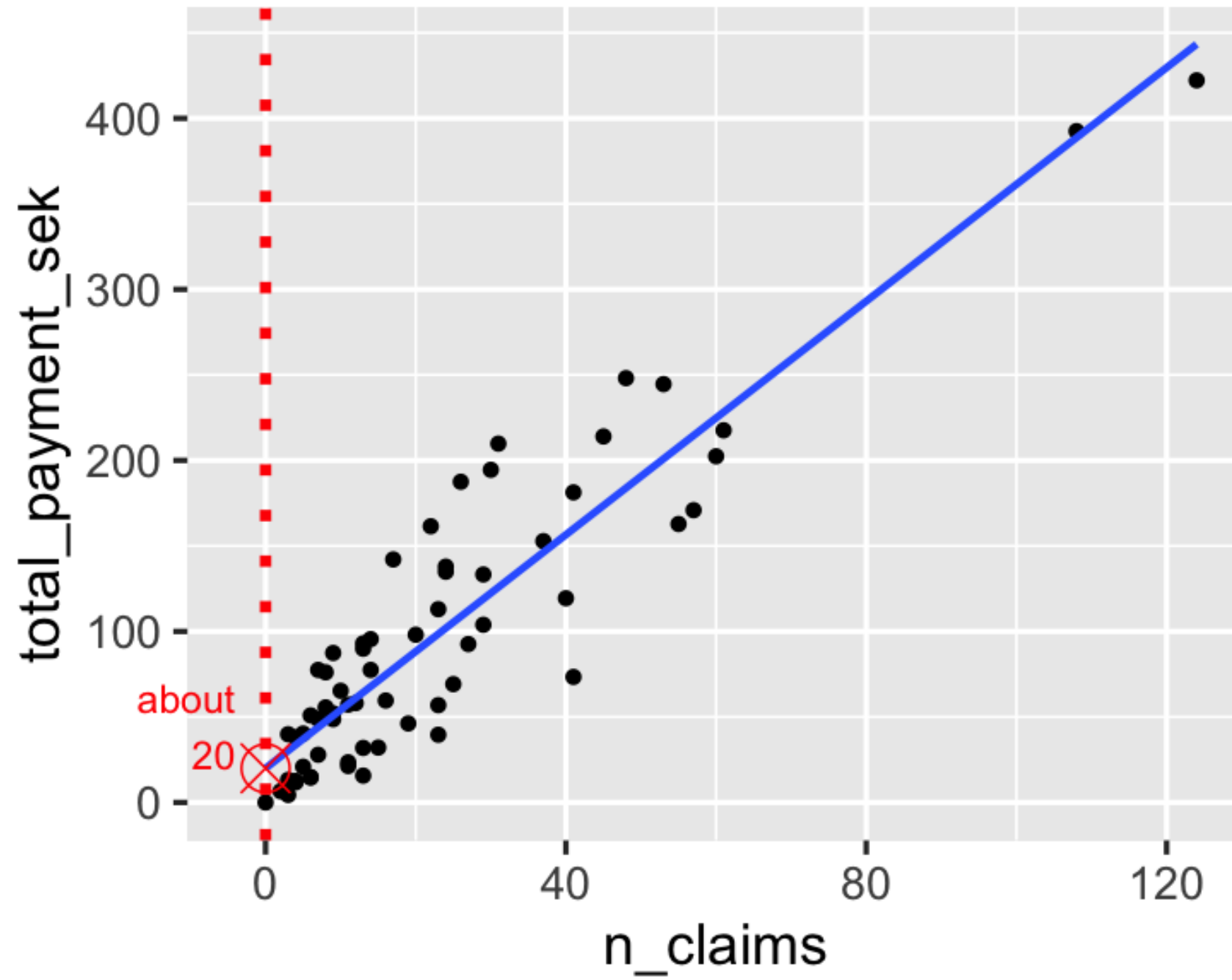
Estimating the intercept



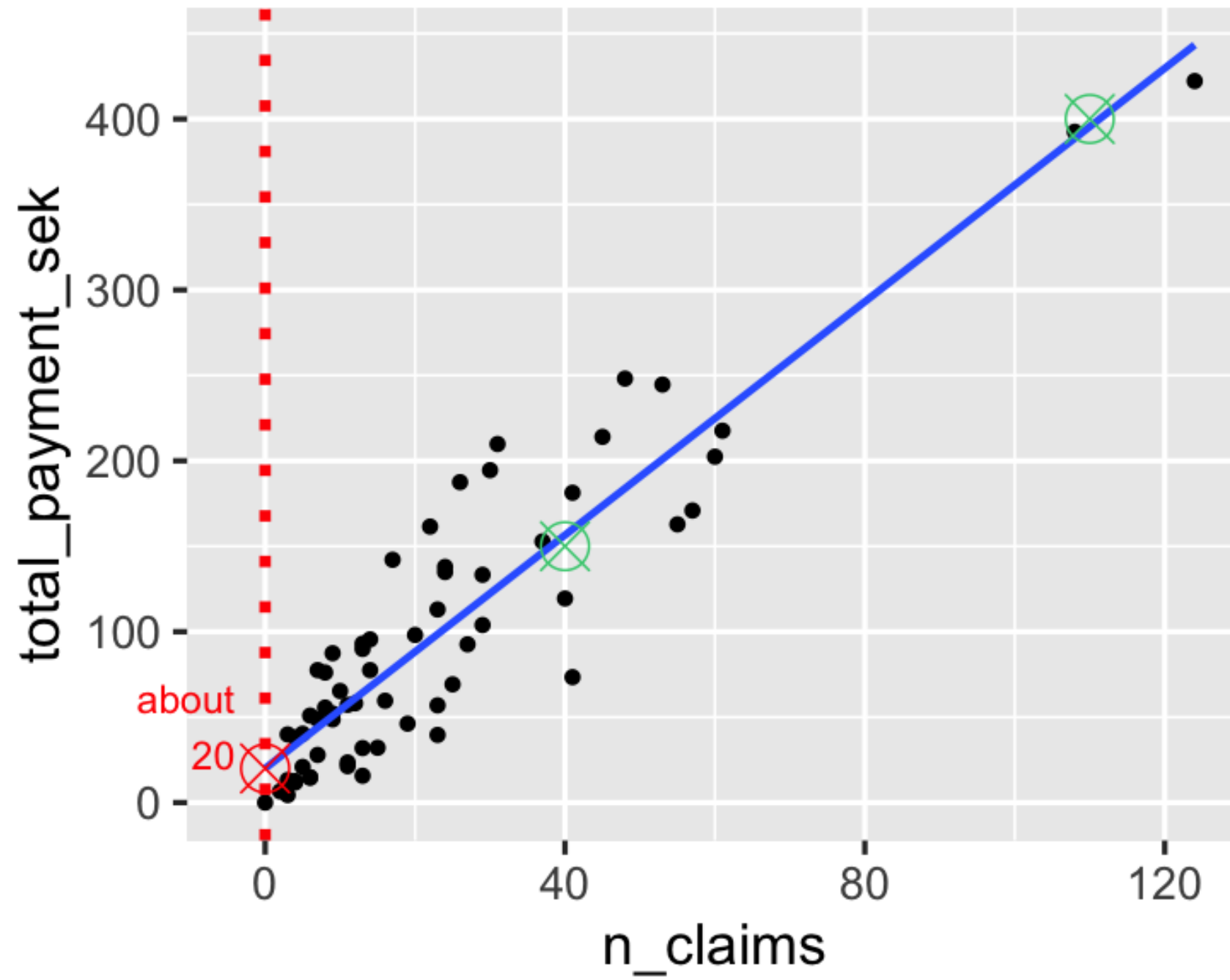
Estimating the intercept



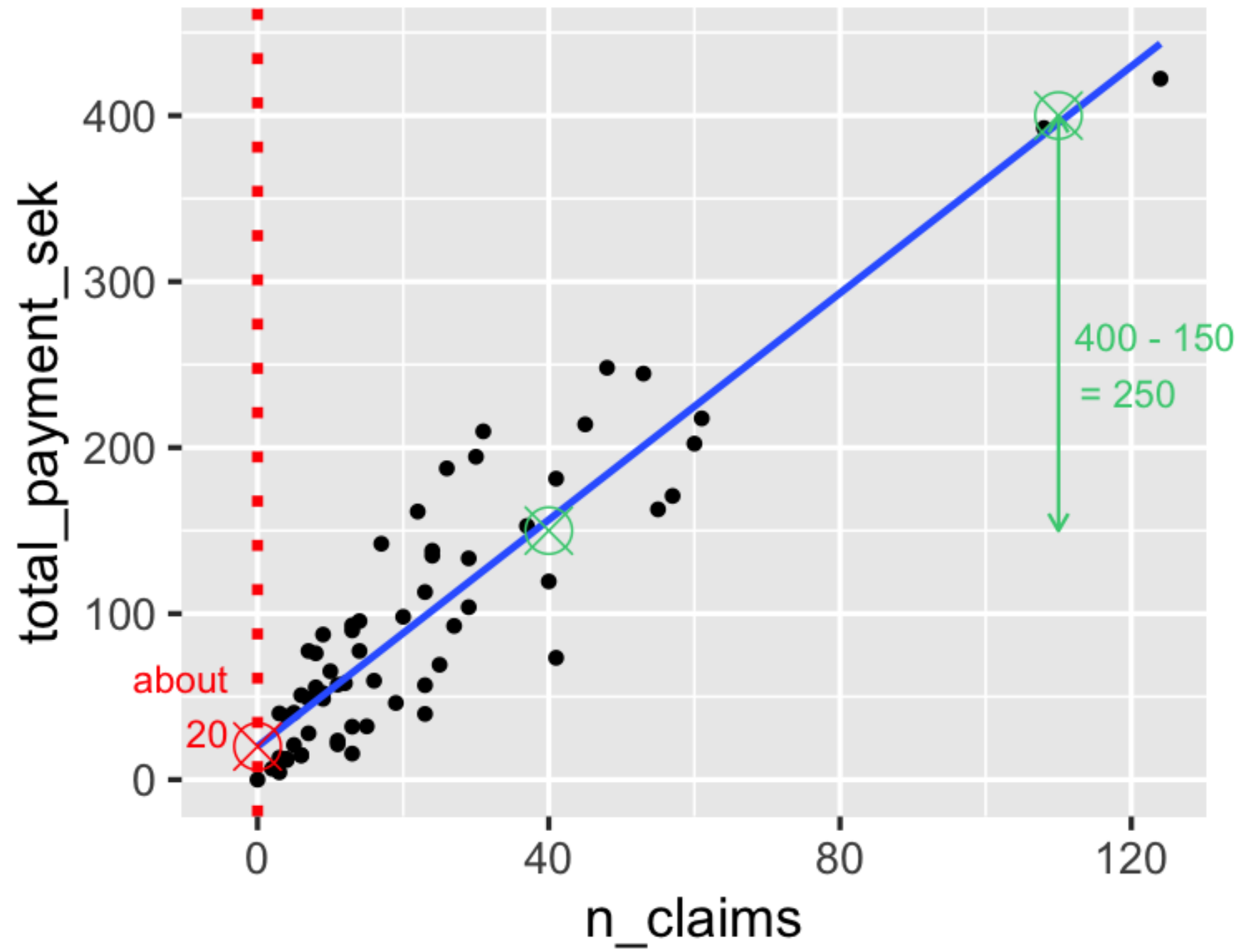
Estimating the intercept



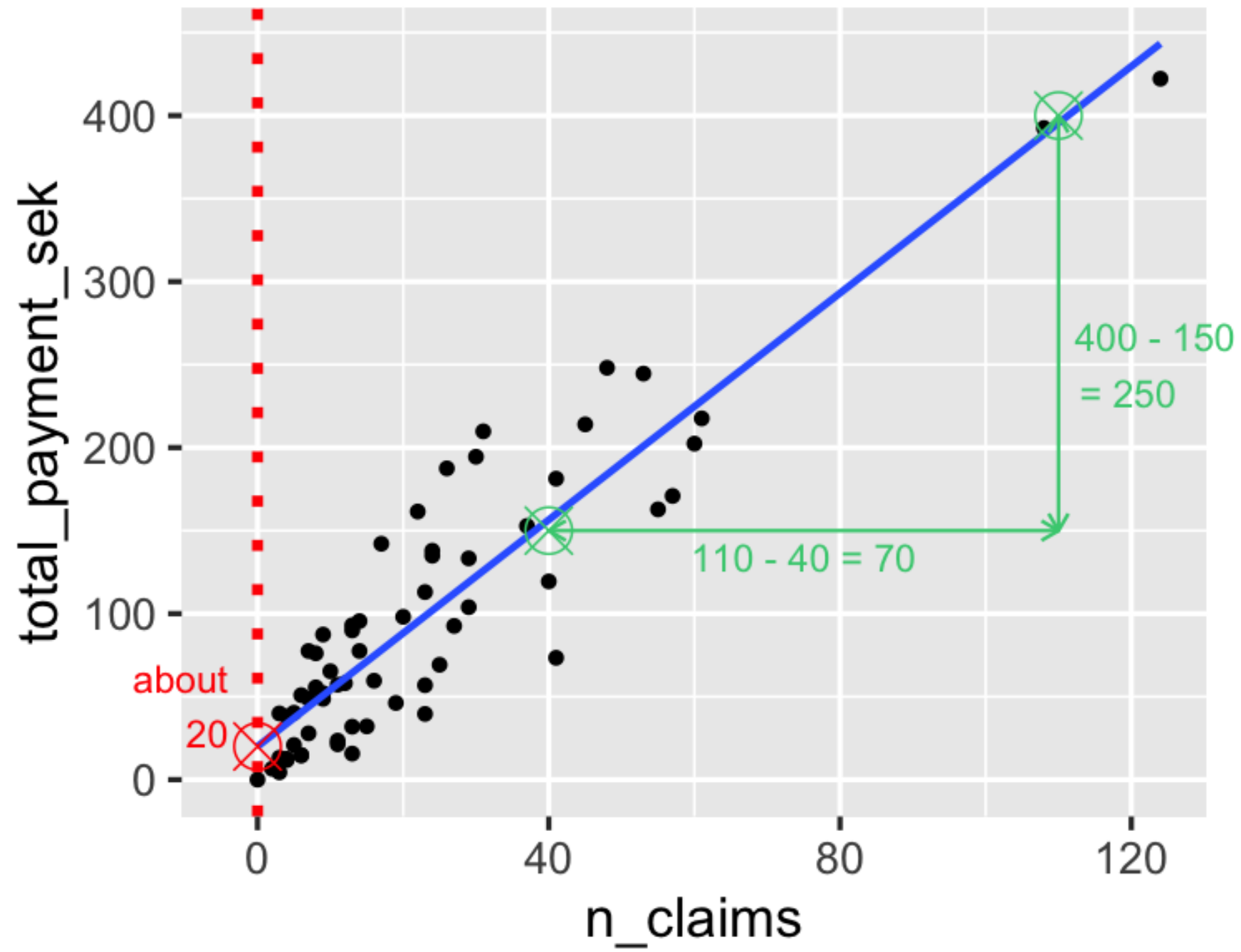
Estimating the slope



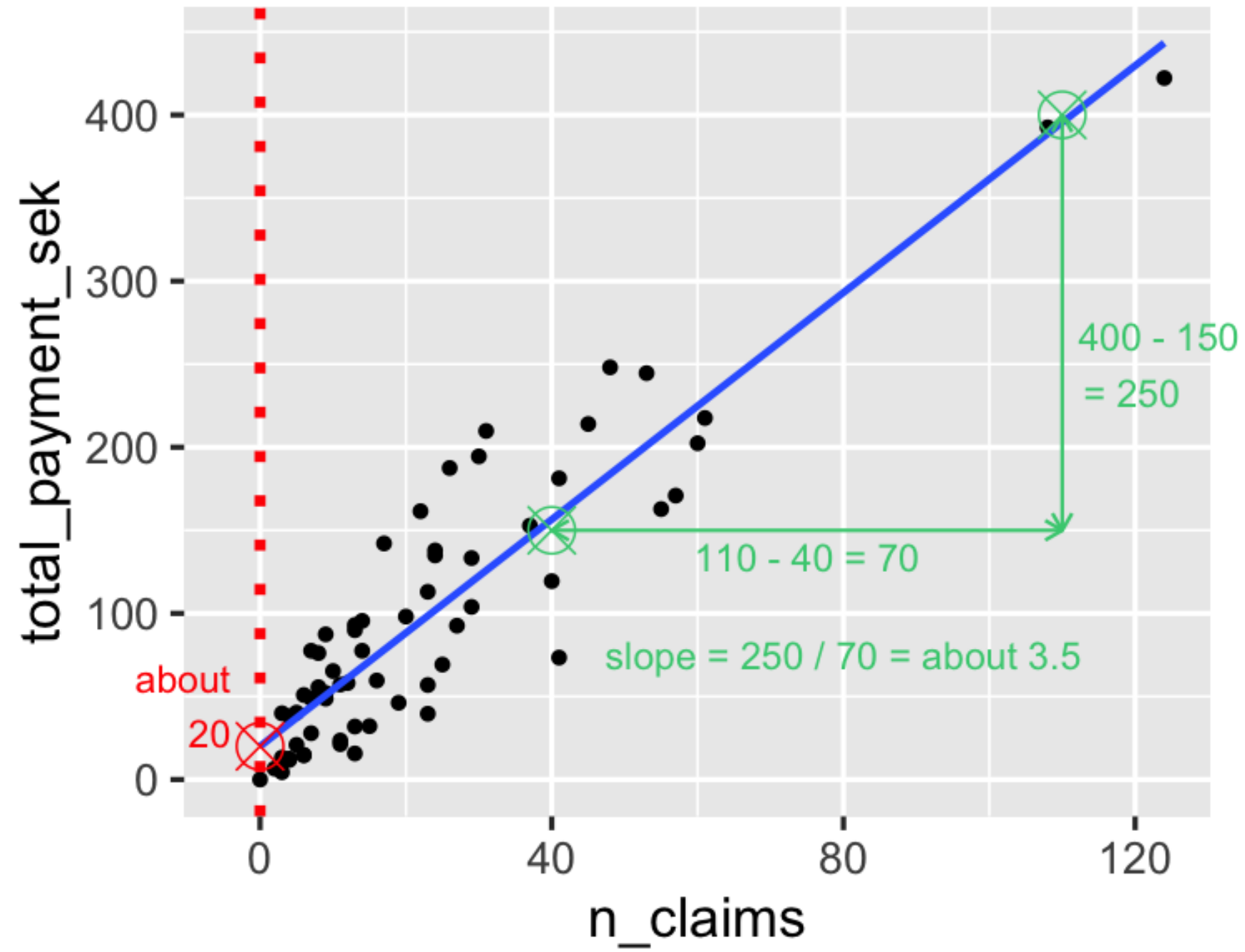
Estimating the slope



Estimating the slope



Estimating the slope



Running a model

```
from statsmodels.formula.api import ols
mdl_payment_vs_claims = ols("total_payment_sek ~ n_claims",
                             data=swedish_motor_insurance)

mdl_payment_vs_claims = mdl_payment_vs_claims.fit()
print(mdl_payment_vs_claims.params)
```

```
Intercept    19.994486
n_claims      3.413824
dtype: float64
```

Interpreting the model coefficients

```
Intercept    19.994486  
n_claims     3.413824  
dtype: float64
```

Equation

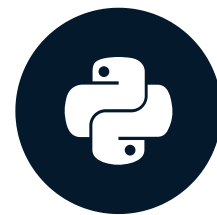
$$\text{total_payment_sek} = 19.99 + 3.41 * \text{n_claims}$$

Let's practice!

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Categorical explanatory variables

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Fish dataset

- Each row represents one fish.
- There are 128 rows in the dataset.
- There are 4 species of fish:
 - Common Bream
 - European Perch
 - Northern Pike
 - Common Roach

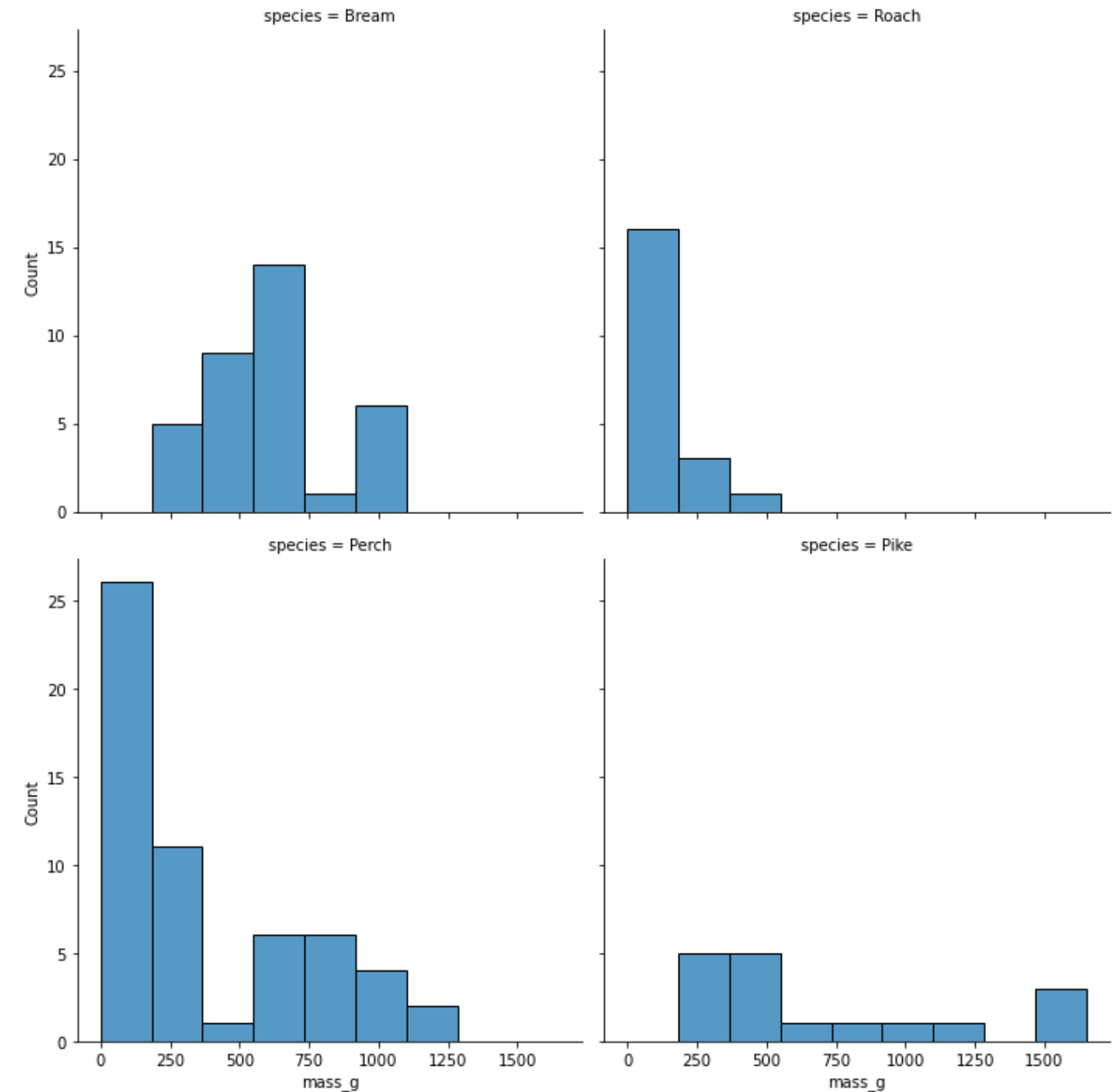
species	mass_g
Bream	242.0
Perch	5.9
Pike	200.0
Roach	40.0
...	...

Visualizing 1 numeric and 1 categorical variable

```
import matplotlib.pyplot as plt
import seaborn as sns
```

```
sns.displot(data=fish,
            x="mass_g",
            col="species",
            col_wrap=2,
            bins=9)
```

```
plt.show()
```



Summary statistics: mean mass by species

```
summary_stats = fish.groupby("species")["mass_g"].mean()  
print(summary_stats)
```

```
species  
Bream      617.828571  
Perch      382.239286  
Pike       718.705882  
Roach      152.050000  
Name: mass_g, dtype: float64
```

Linear regression

```
from statsmodels.formula.api import ols
mdl_mass_vs_species = ols("mass_g ~ species", data=fish).fit()
print(mdl_mass_vs_species.params)
```

```
Intercept          617.828571
species[T.Perch]   -235.589286
species[T.Pike]     100.877311
species[T.Roach]   -465.778571
```

Model with or without an intercept

From previous slide, model with intercept

```
mdl_mass_vs_species = ols(  
    "mass_g ~ species", data=fish).fit()  
print(mdl_mass_vs_species.params)
```

Intercept	617.828571
species[T.Perch]	-235.589286
species[T.Pike]	100.877311
species[T.Roach]	-465.778571

The coefficients are relative to the intercept:
 $617.83 - 235.59 = 382.24!$

Model without an intercept

```
mdl_mass_vs_species = ols(  
    "mass_g ~ species + 0", data=fish).fit()  
print(mdl_mass_vs_species.params)
```

species[Bream]	617.828571
species[Perch]	382.239286
species[Pike]	718.705882
species[Roach]	152.050000

In case of a single, categorical variable,
coefficients are the means.

Let's practice!

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