A tale of two variables

INTRODUCTION TO REGRESSION WITH STATSMODELS IN PYTHON

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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

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

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

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

```
0.9128782350234068
```

What is regression?

- Statistical models to explore the relationship between 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

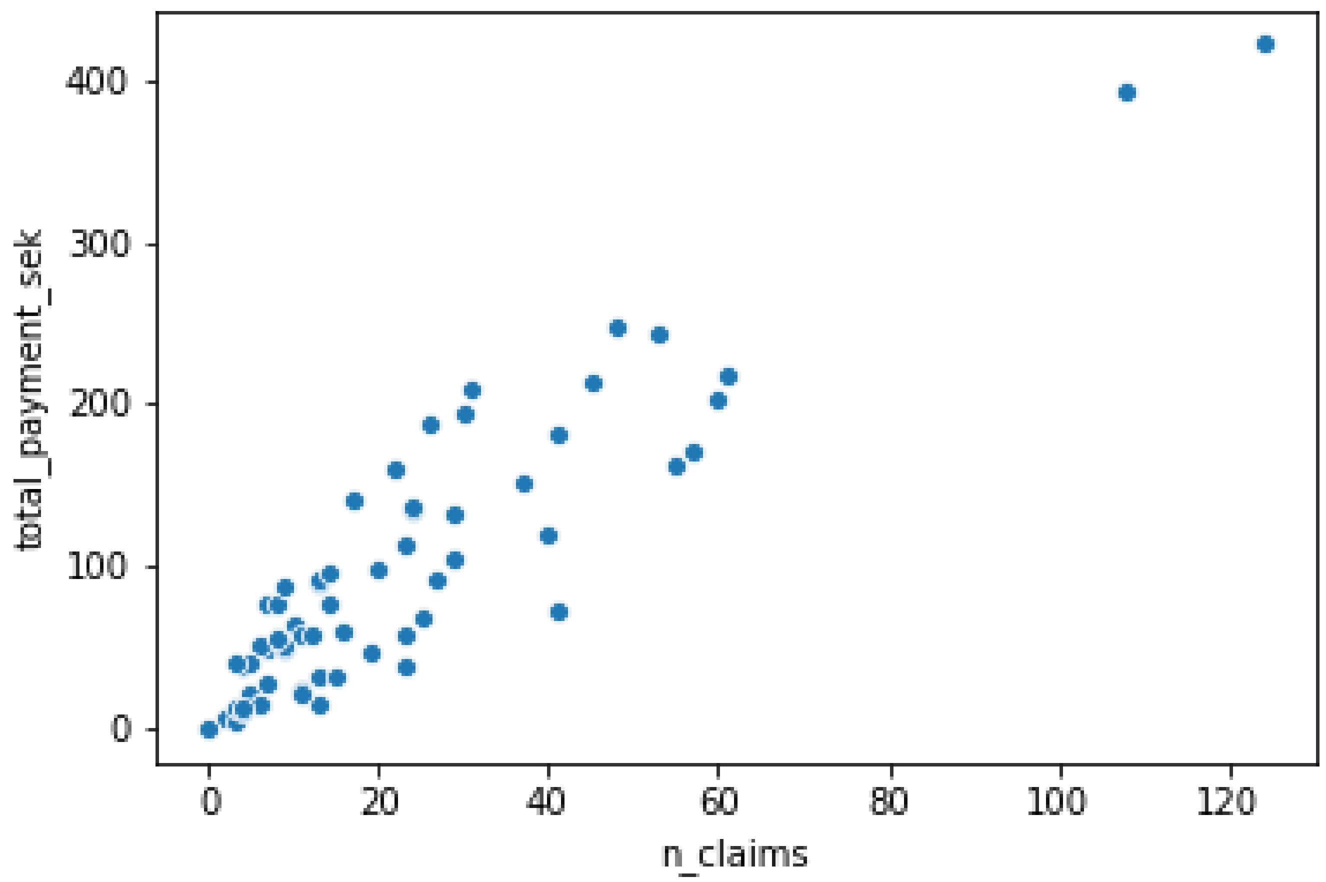
- The response variable is logical.

Simple linear/logistic regression

- There is only one explanatory variable.

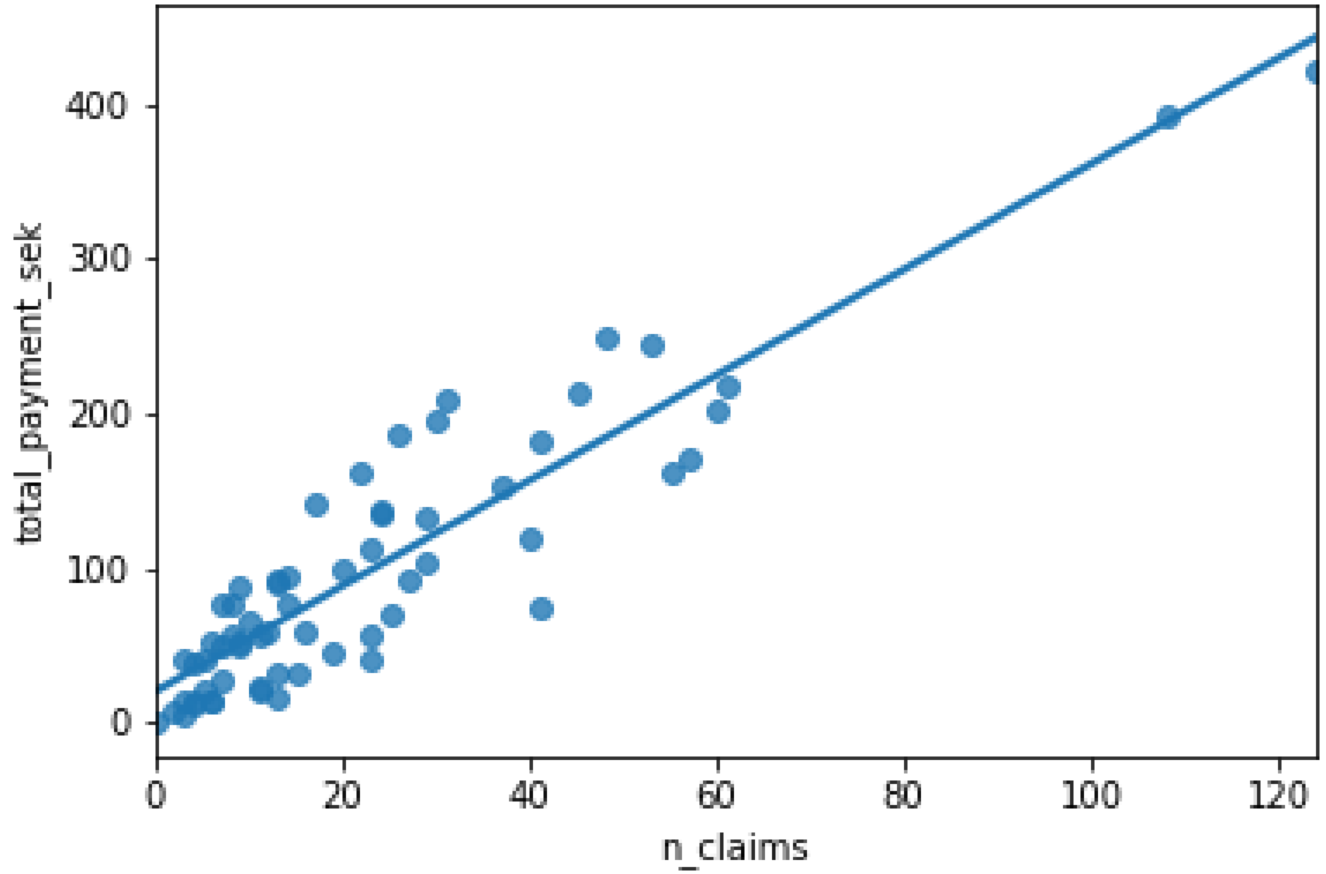
Visualizing pairs of variables

```
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!

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.

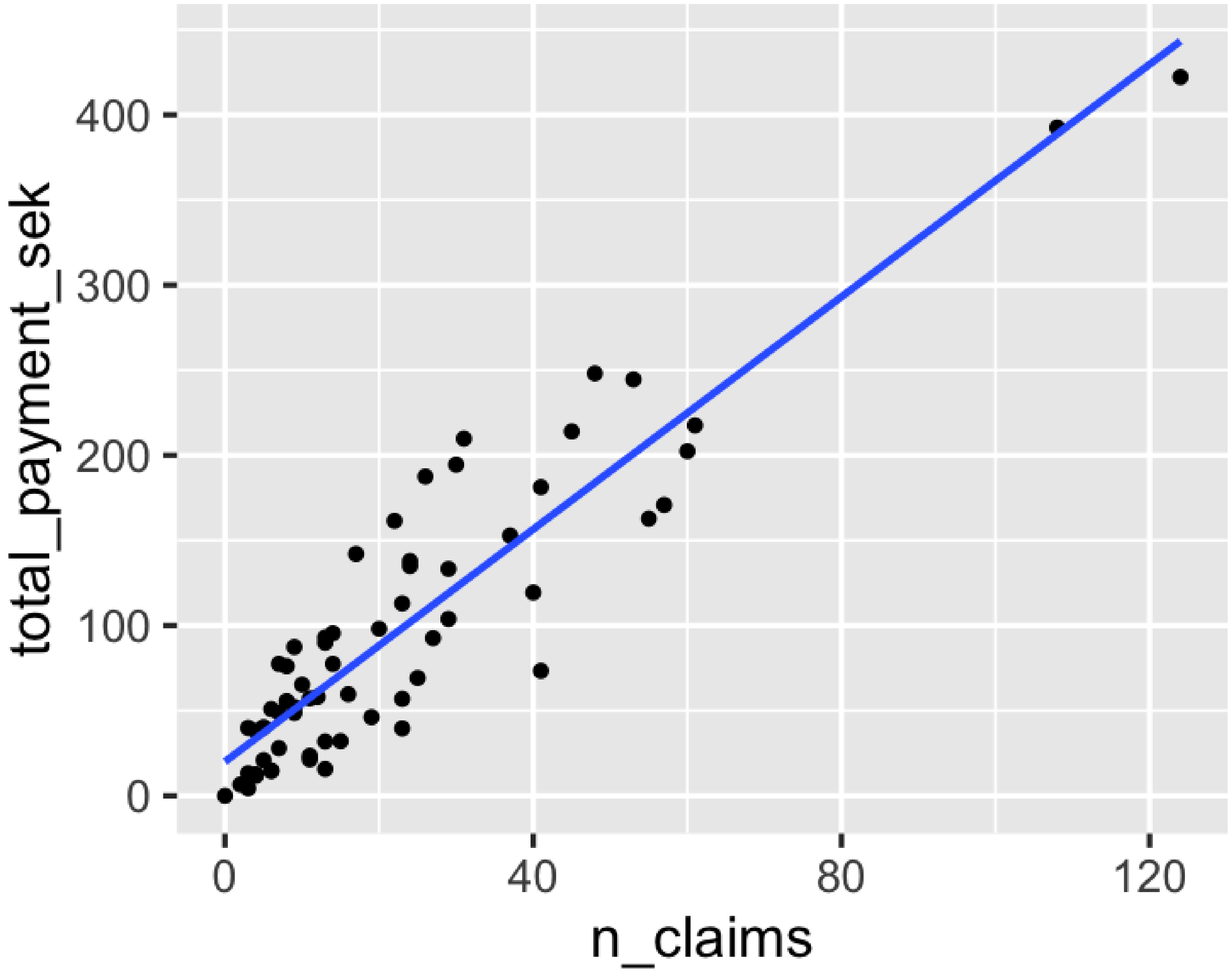
Slope

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

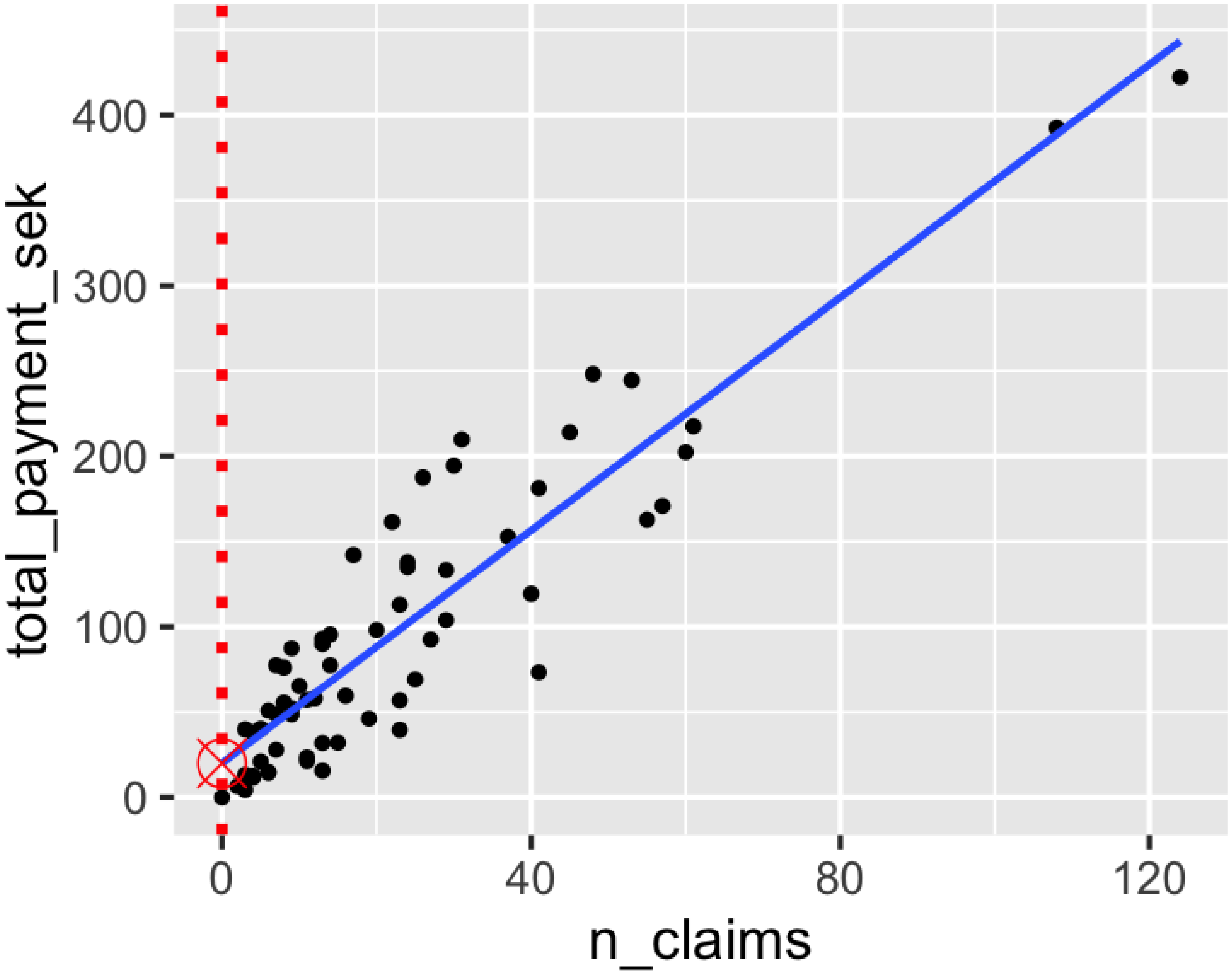
Equation

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

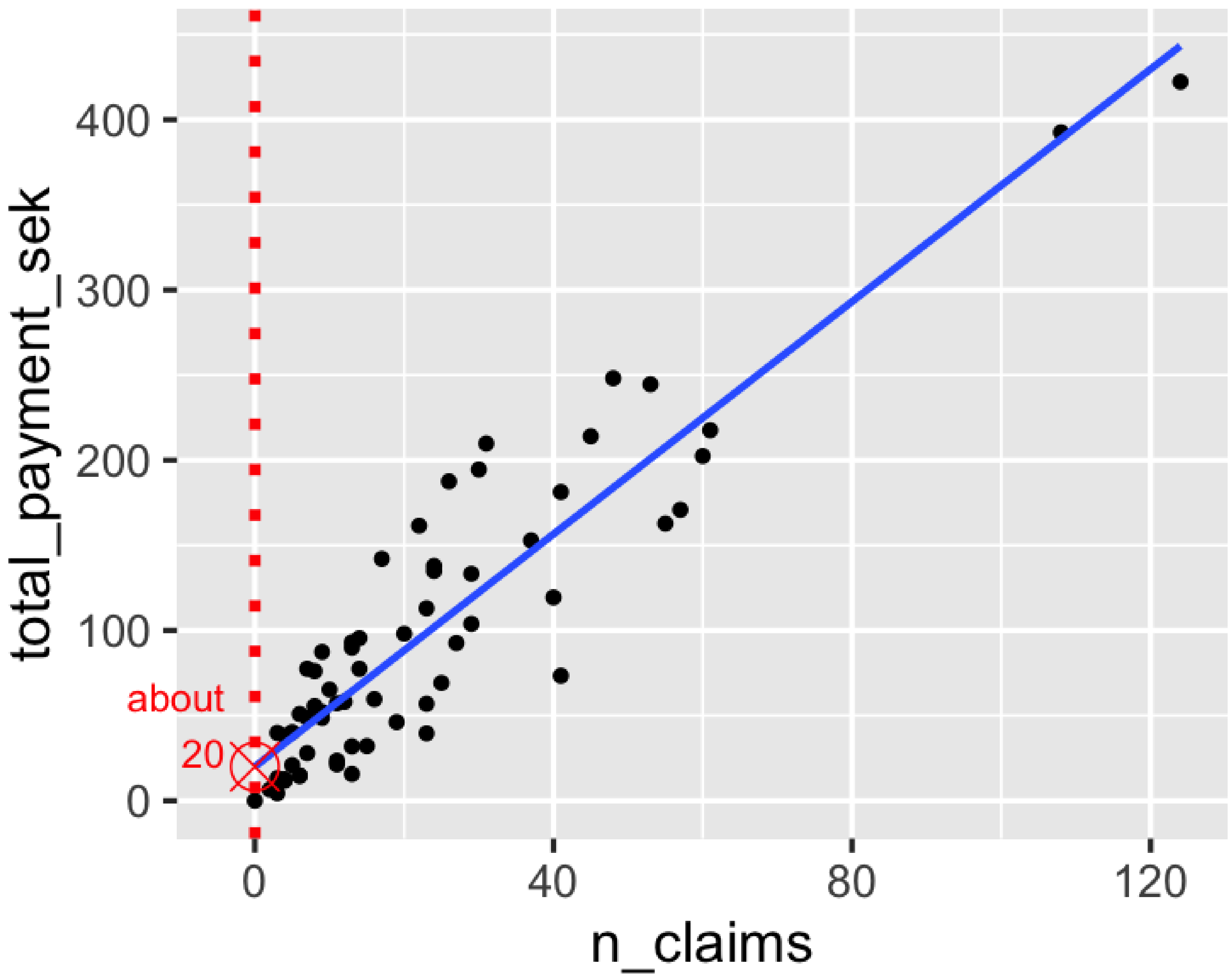
Estimating the intercept



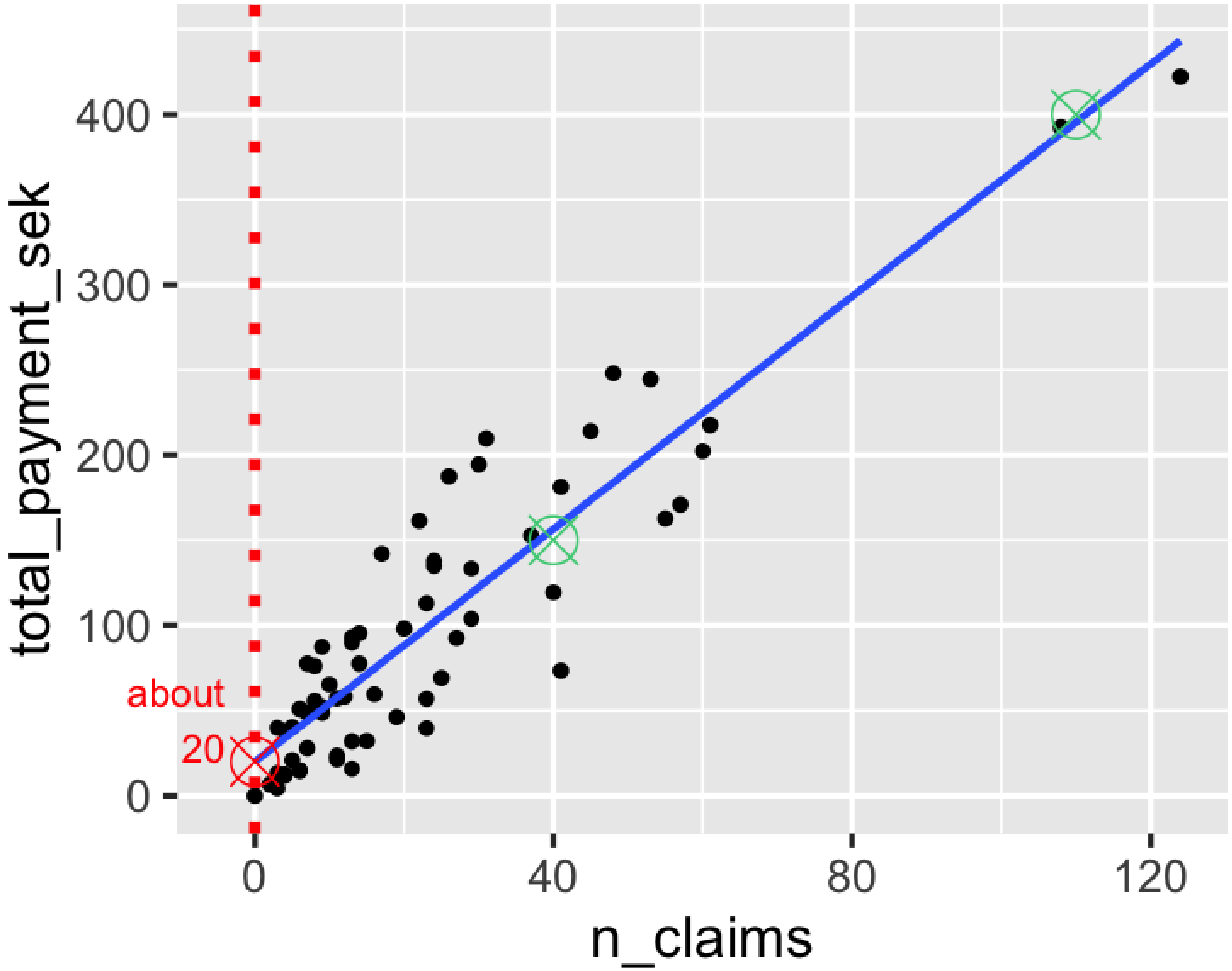
Estimating the intercept



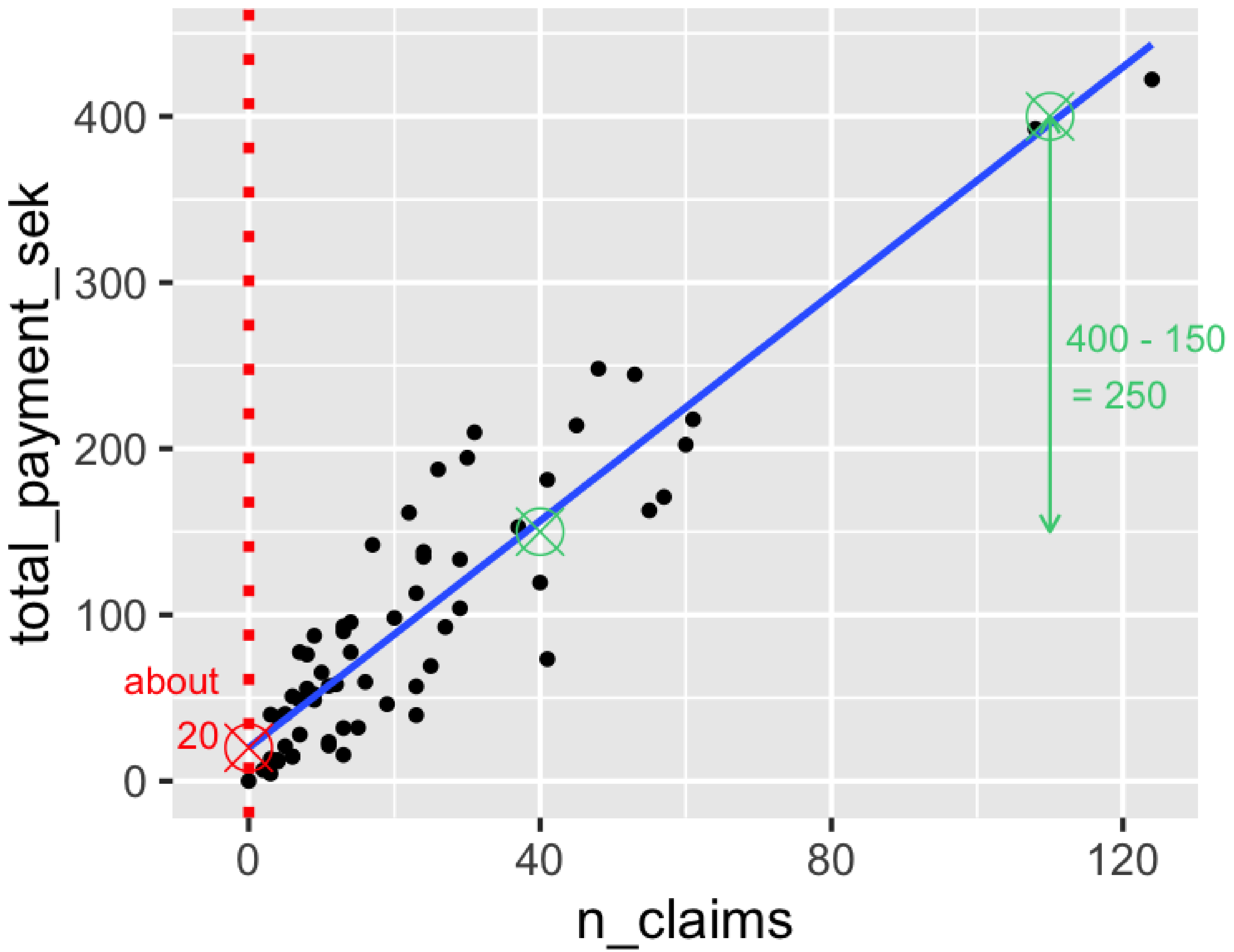
Estimating the intercept



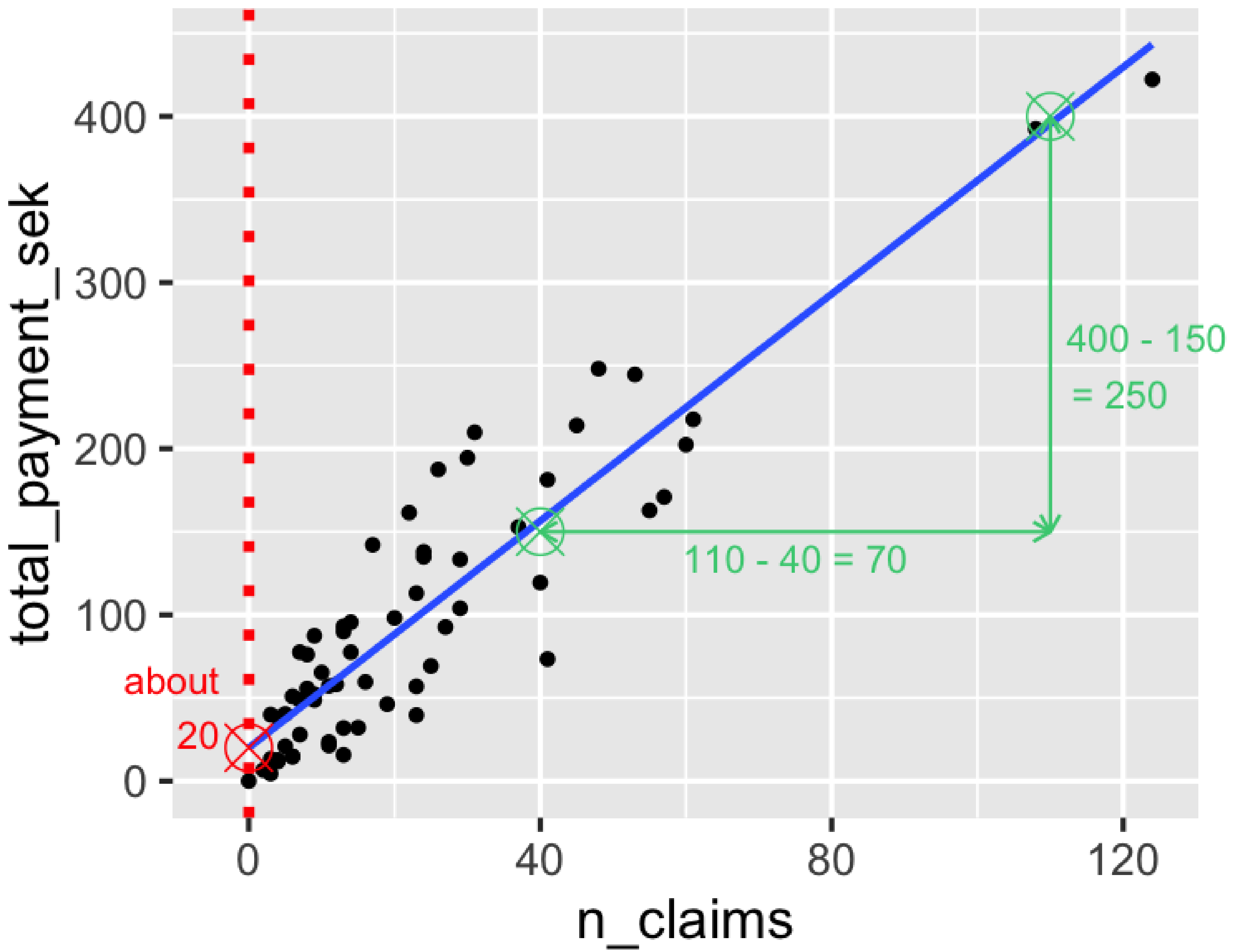
Estimating the slope



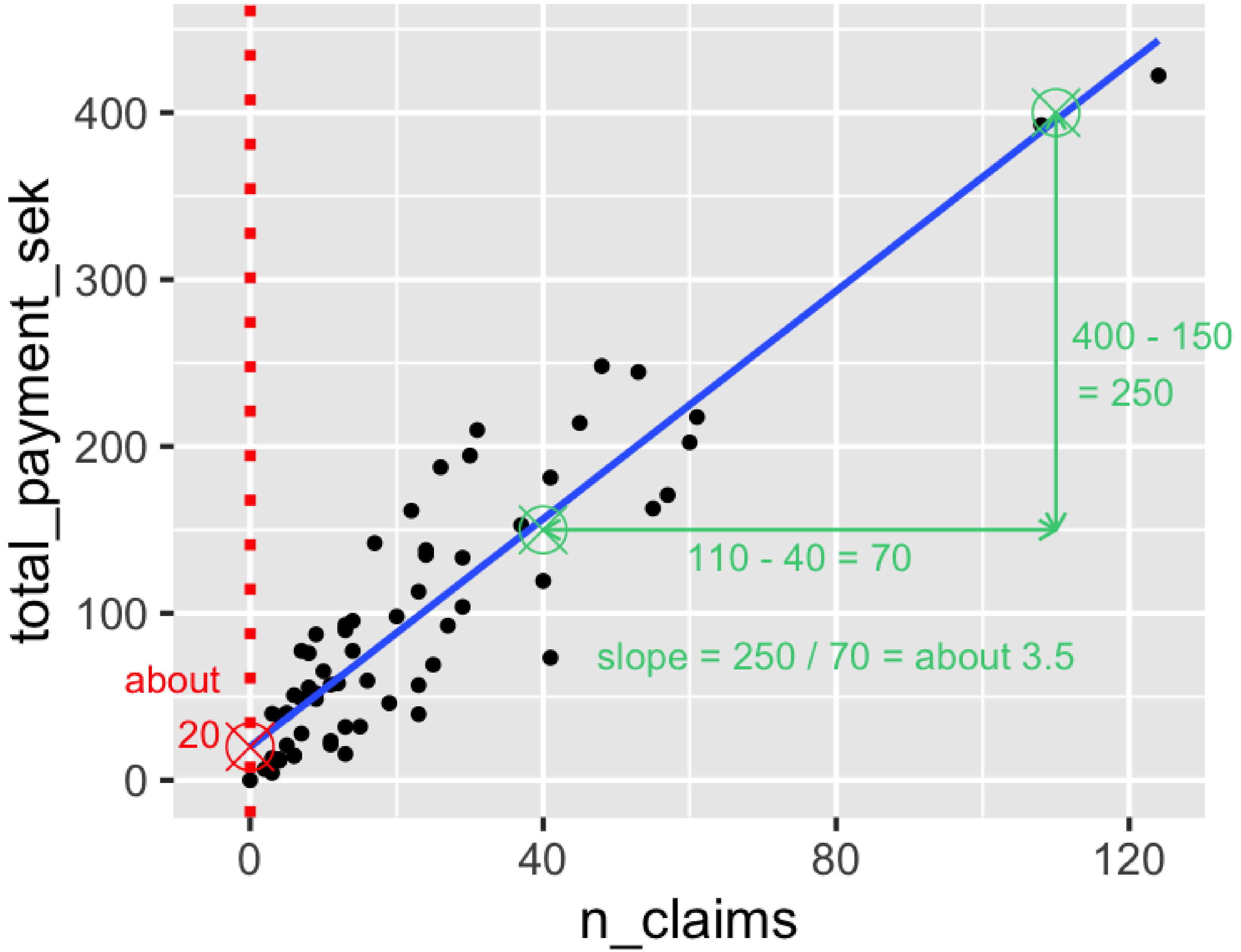
Estimating the slope



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!

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

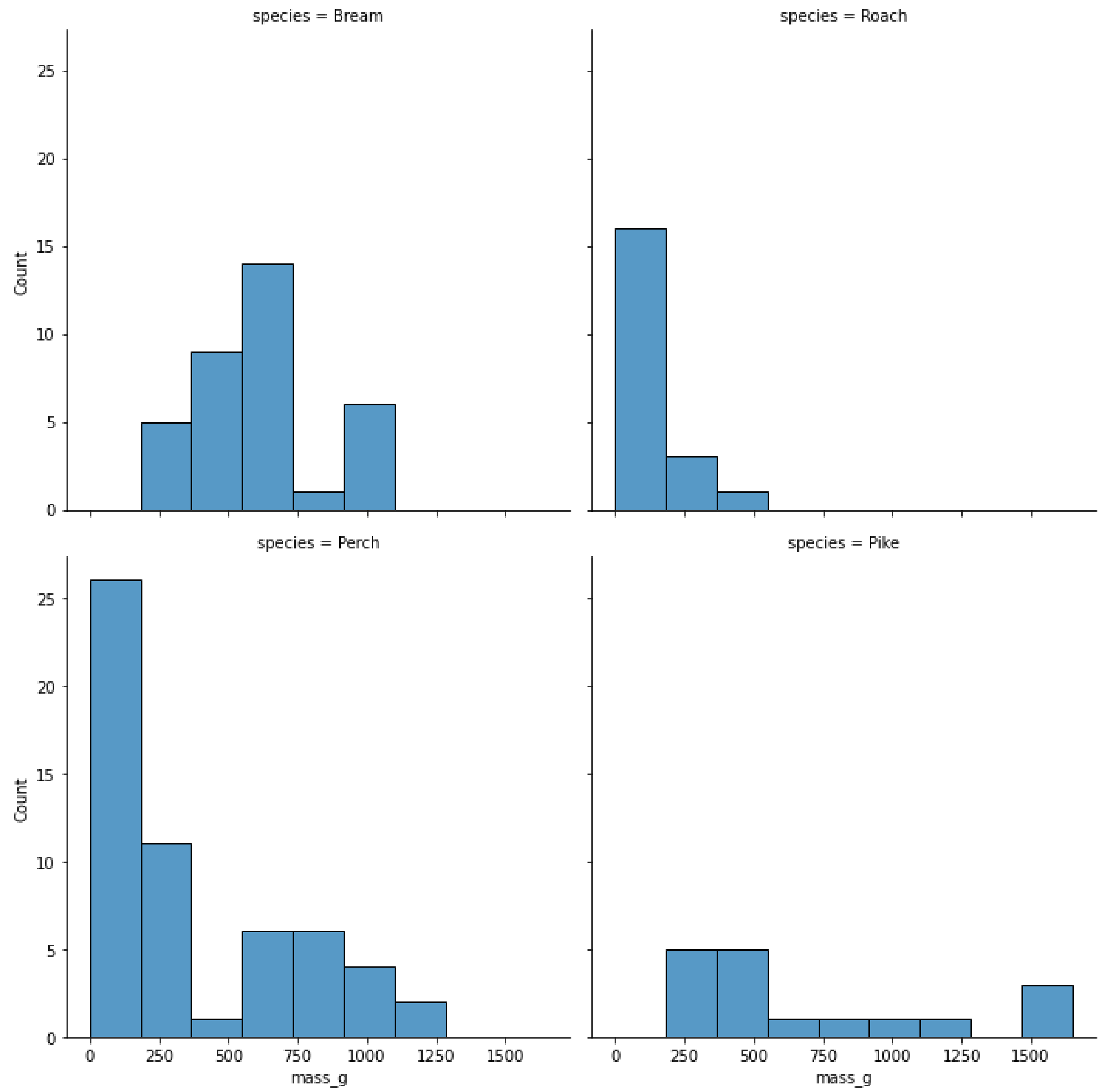
species	mass_g
Bream	242.0
Perch	5.9
Pike	200.0
Roach	40.0
...	...

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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